DataLOGIC

Information Needs Assessments for the Definition of Inventory & Monitoring Data Products and Conceptual Object Model

Prepared For:

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Southeast Coast Network

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1. Background

The Southeast Coast Network (SECN) of the National Park Service is advancing its Inventory and Monitoring Program to provide the foundation for long-term management that will preserve, protect and maintain the health of park ecosystems, natural resources and historic and cultural sites. SECN has expressed the need to integrate their monitoring program to meet the National Park Service (NPS) Inventory and Monitoring Program's five stated goals:

- Conduct baseline inventories
- Develop a coordinated long-term monitoring program
- Develop decision support systems
- Integrate inventory and monitoring programs
- Cooperate with other federal and state agencies

SECN has begun creating baseline inventories of its basic biological and geophysical natural resources. These data inventory layers provide the foundation for agency-wide information resources. SECN has also developed an extensive list of over 400 potential monitoring objectives. These objectives have been subjected to screening by network and park professionals and statistically analyzed for relevance.

To further refine the specification of monitoring objectives and to develop useful and adaptive data products for its inventory and monitoring business, the Southeast Coast Network recognized the need to perform a broad and thorough Information Needs Assessment (INA) that would capture best and current practices among natural resource management professionals.

DataLOGIC was contracted to assist SECN in performing an Information Needs Assessment that would contribute to developing the information requirements that are essential for supporting the inventory and monitoring business, missions of parks and other historic and cultural sites, as well as to address specific user requirements pertaining to monitoring.

The purpose of the INA was to determine what monitoring objectives should be addressed, what monitoring data is needed and desired by SECN to address these objectives, and how that data would be gathered and applied according to monitoring protocols. The INA process described in this section relies on gathering information directly from subject matter experts and potential users. The results of the process include a catalog of detailed information and protocol recommendations from participants as well as a conceptual object model that can serve as a road map for future information management planning.

2. INA Approach

2.1. The INA Process

DataLOGIC advocates a highly structured approach to assessing and synthesizing information needs. The INA process conducted for NPS SECN was inspired by the approach developed by Dr. Roger Tomlinson as described in his book *Thinking About GIS: Geographic Information System Planning for Managers* (ESRI Press, 2003). Dr. Tomlinson advocates early identification of information needs within an organization, offers a practical approach for gathering feedback and provides a formalized process for needs assessment.

The core of the formalized process is the creation of an information product description (IPD) for each monitoring need that workshop participants consider priority needs. An information product is simply a potential user's desired outcome from an analysis tool like GIS, including items like maps, tables, graphs, etc. Information products require data for their creation. They are the products that support decision-making and analysis in the field. Figure 1 shows the relationship between data and an information product.

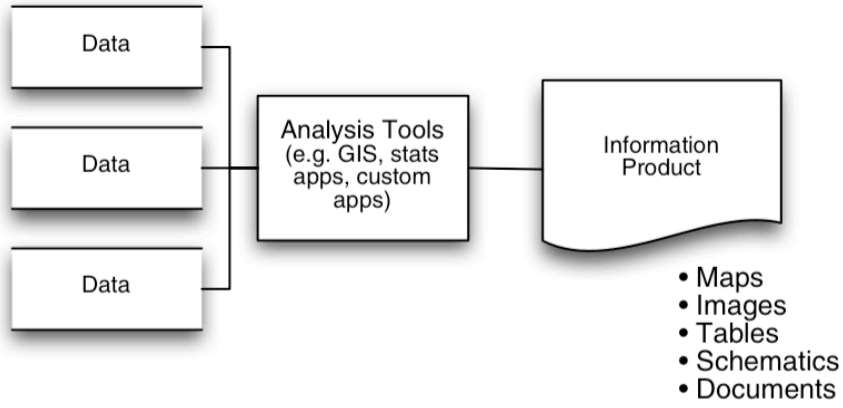


Figure 1. The relationship between data and information products

The description of information products can be used later in protocol and application design and are entirely motivated by the needs of potential users. Using IPDs as a basis for the needs assessment insures that only relevant and practical data will be considered for collection and monitoring.

The results of this process are based in large part on the ability of the INA to create order out of chaos. The task of assessing monitoring data needs is quite vast and potentially overwhelming without a structured process to establish information priorities. Upon initiating the INA at the network level, there was considerable discussion about how to construct the assessment process in a way that would produce focused results. When users are asked something as general as "What monitoring information do you need?" their responses can range from sophisticated products like interactive maps displaying trend analysis of multidimensional data to highly condensed reports to individual attributes about single items in the park. The potential amount of data is quite large as is the potential number of information products that would require monitoring data.

In the structured INA process, we pose deliberate questions that generate productive discussions and detailed responses. From those responses, we can sort what would have been a tangle of unclassified needs into two broad categories of data and information products. Figure 2 shows

how the structured INA process includes analysis that untangles the initially complex and potentially confusing view of user needs. It also identifies data that are required by a large number of information products vs. data that are used relatively seldom or perhaps not at all.

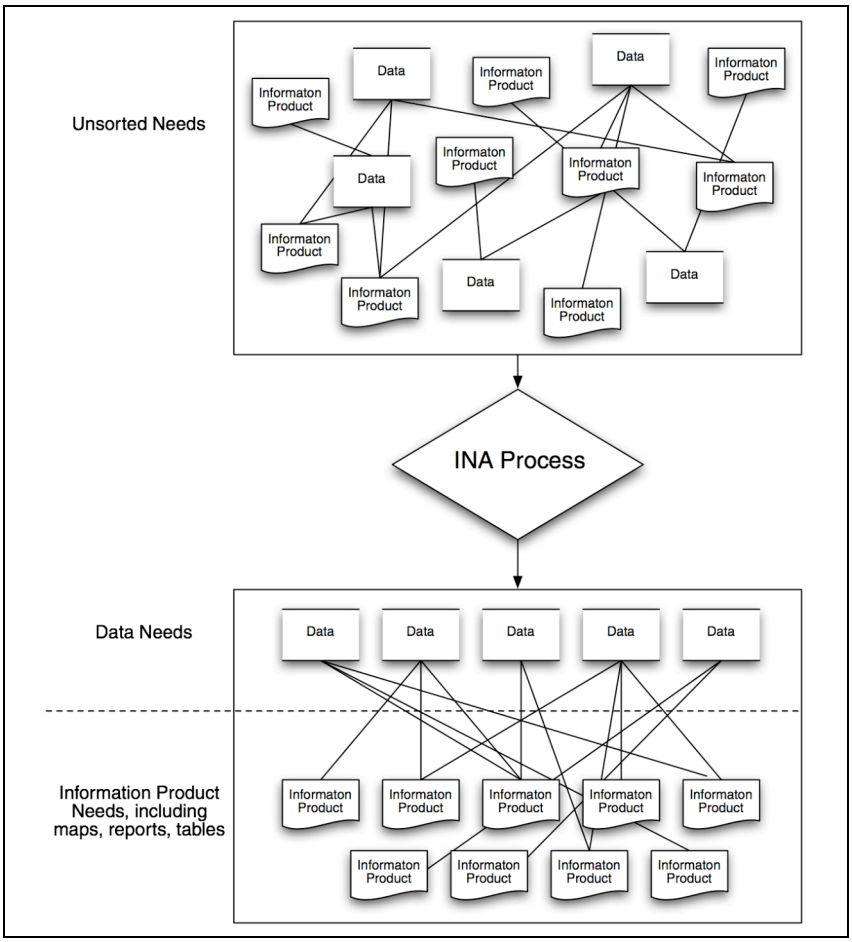


Figure 2. The structured INA process sorts the tangle of data and information products into quantifiable sets.

2.2. Methodology

Rapid and efficient collection of user-driven monitoring needs was accomplished through a series of planning meetings and workshops (regional and field scoping meetings) that focused on the development of Information Product Descriptions. Using the 400+ potential monitoring objectives that SECN had pre-identified, the planning meetings focused on selecting candidate monitoring objectives for the workshops based on subject matter and statistical analysis of relevance according to park and network personnel (For additional information on the selection of Vital Signs, please refer to Appendix 4 at http://www1.nature.nps.gov/im/units/secn/monitoring.htm). The five field workshops were led by members of SECN's Inventory and Monitoring Program staff (Christina Wright, Joe DeVivo, Eva DiDonato and Michael Byrne) together with DataLOGIC personnel. The theme of each workshop was selected according to common ecosystems or subject matter: Remote Sensing, Estuarine and Marine Habitats, Rivers and Streams, Wildlife,

and Vegetation. Each workshop hosted between eight and nineteen participants including park staff and resource managers, NPS regional scientific staff, academicians, monitoring personnel from other state, local and federal agencies and contractors. Participants were selected based on expertise and experience in monitoring of natural resources. Attendees for each workshop are listed in Appendix 1.

A project web site was created and maintained by DataLOGIC. It provided workshop logistics information, introductory material and IPDs for review. An illustration of the project site is shown in Appendix 2.

Each scoping workshop lasted two full days and followed a similar agenda. A sample agenda is included as Appendix 3. Following overview and introductory sessions, the entire group brainstormed collectively to establish priorities among possible monitoring objectives.

Based on each monitoring objective that was given sufficient priority by the group, an information product description was created using an IPD template to structure responses and document the process. Appendix 4 contains the IPD template that was initially used to create the information product descriptions; later workshops did not include items such as frequency of use and potential users but focused on protocols and data requirements.

During these working group sessions the document was projected on a screen for each small group (if possible) as it was being written. Participants were highly engaged and there were lively discussions as they collectively wrote each information product description. The IPDs are indexed in Appendix 5 and the complete catalog of IPDs is contained in Appendix 6. After several working group sessions to create IPDs, each INA session was concluded with a roundtable-style brainstorming discussion about the design of monitoring programs.

Other sources of information for the needs assessment included SECN's museum specialist, Kate Dahl-Kearney, who provided information related to archives and specimens. In lieu of a meeting dedicated to fisheries, a very detailed report from USGS provided useful information for the modeling process[1].

The workshops and the associated information products yielded critical information about the data and protocols that can be used by the long-term monitoring program. The data described in the workshops and the relationships between the data were used to develop a conceptual object model of the data that can be used and adapted by the SECN information management planning team; the model is discussed in detail in Section 3 of this report. Appendix 7 shows how the information products and the data objects included in the model correlate with each other.

Figure 3 summarizes the steps performed for the overall Information Needs Assessment process.

[1] Revised protocols for sampling algal, invertebrate, and fish communities as part of the National Water-Quality Assessment Program", Stephen R. Moulton II, Jonathan G. Kennen, Robert M. Goldstein, and Julie A. Hambrook, USGS Open-File Report 02-150, available at http://water.usgs.gov/nawqa/protocols/OFR02-150/

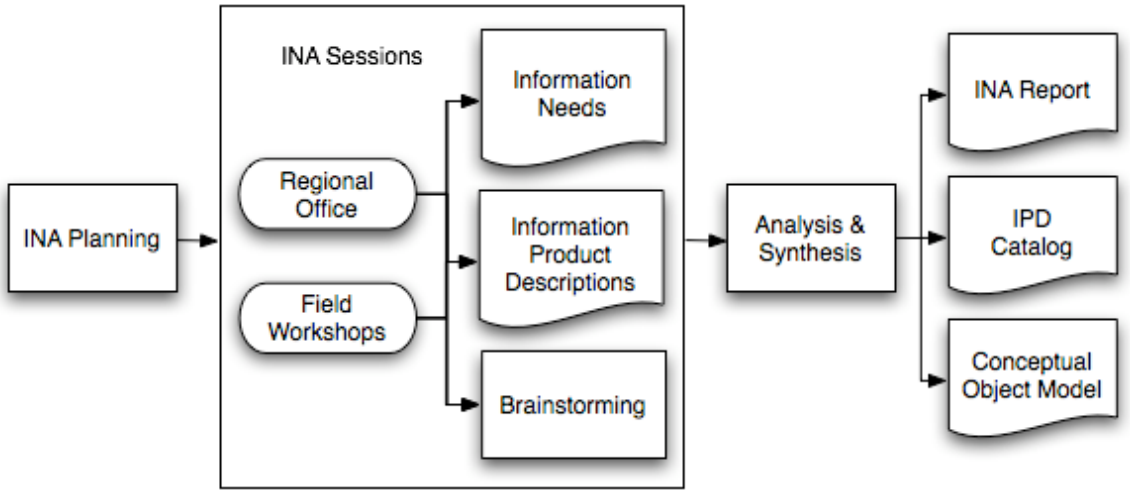


Figure 3. The INA Process and Results

2.3. Value of INA Process

As seen in Figure 4, several factors contribute to the value of the INA process:

- As active participants in the INA, experts and potential users become engaged and invested early in the information technology adoption process, thereby increasing their likelihood of successfully adopting any new systems and procedures that may result.
- The process facilitates the rapid acquisition of information needs while simultaneously capturing the breadth and depth of those needs.
- The results of the INA have lasting value as the design of the monitoring program moves ahead. The conceptual object model and other results will be available to streamline database and systems design and other information management planning phases. Detailed descriptions of information products will also be useful for systems and interface designers who work on specific applications that involve monitoring data.

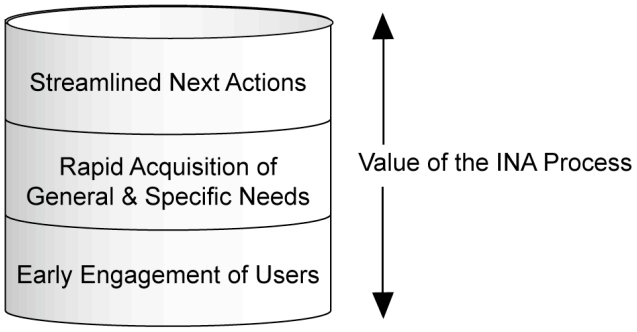


Figure 4. The value of the INA process is compounded by several factors.

3. Conceptual Object Model for Natural Resources Inventory and Monitoring

3.1. Purpose of Object Modeling

In order to build an information management and decision support system that is suitable for Natural Resources Inventory and Monitoring, the first step is to develop a solid understanding of what the I&M process entails. Our approach uses the IPDs to understand the business functions that potential users need to perform and the type of information they need in order to do this work. Object-Oriented Data Modeling, or simply Object Modeling, refers to the process of identifying these business functions and organizing them into a series of logical components that represent real-world entities that are familiar to users. The result of this process is known as an Object Model.

The goal of object modeling is to identify the business processes used by an organization and express them in terms of real-world "objects" that make up these processes and functions. Using this approach, a database management system, and the potential queries, reports and applications based on such a system can later be structured around the actual business objects that are familiar to potential users. Using an object-oriented approach helps produce a better understanding of the business elements, which results in a more understandable database design and leads to systems that more closely match user's needs and expectations.

An object model is not the same thing as a database design. An object model is intended to produce a conceptual representation of the various business entities that potential users of the system interact with, whereas a database design is an implementation of the model that provides a means of creating, storing, and working with (reporting on) the objects in the model. It is important to keep this distinction in mind when reviewing the object model; the model is not intended to represent a database design or any type of pre-defined database structure, nor is it intended to imply data flow from one object to another. The purpose of the model is to address the business needs of potential users so that a data storage system can ultimately be developed that supports the needs of the user, rather than developing a database that could cause users to change their business approach just to be able to store their data.

3.2. Object Model Development

The Information Product Descriptions (IPDs) that were developed during the INA process form the basis for the object model. Information received from the INA process, as expressed in the IPDs, was used to identify the actual real-world objects used by the natural resources community, and the relationships between these objects that will support the information products that users need.

The INA reports and IPDs were evaluated and organized by business process to help determine the various objects depicted in the model. Because of this, the model is a representation of the current and/or desired business components used by natural resource specialists; it is based on the stated business practices and needs of the user community, not necessarily on how their data is currently being stored. In some cases, the model may closely match current data storage techniques, but in other cases it may not. Once the model has been completed, it can be further developed into a database design that will provide a foundation for future data storage and application development efforts.

The object model presented in this document is not a static model; rather, it is a conceptual model that will be subject to growth and change over time as new objects are identified and existing objects become more refined. When reviewing the model diagrams, it is important to keep in mind that no attempt has been made to create an exhaustive, all-inclusive list of objects

and properties. The objects in the diagrams represent key components that have been identified to help support the needs described in the IPDs, and are intended as a stepping-off point for further future development. In some cases, objects have been identified and added to the model as placeholders, often without properties, to represent examples of the type of objects that may exist at that level; the model is not meant to imply that the objects shown are the only ones that may exist at any particular level.

3.3. Object Model Components

The NPS Natural Resources Inventory and Monitoring Object Model diagram depicts the various objects, properties and conceptual relationships included in the model. The following describes the various model components and describes the role of each in the model, along with descriptions of how to read and interpret the symbology used in the model.

3.3.1. Objects and Properties

The object model is a logical representation of real-world entities, or objects. An object is any item that has an identity, structure, or behavior. In a conceptual model, an object can be a tangible, physical "thing" (for example, a Fish Specimen), an activity (such as a Sampling Event), or even something that is more of a concept (such as a Data Analysis).

There are three different types of objects included in the model:

- *Reference Objects*

  Reference Objects are objects that are an integral part of the model but are generally not maintained by the SECN. They may be datasets that are obtained from other outside agencies on an ongoing basis, or they may be maintained by other groups or departments within the NPS. These objects are generally displayed in the model without any associated properties. An example of a Reference object would be species information provided by ITIS.

  Reference objects are depicted in the model using this symbol: 

- *Data Collection Objects*

  Data Collection Objects are objects that are primarily related to actual field data collection activities, or other data gathering operations performed by the SECN in support of the Inventory and Monitoring Program. An example of a Data Collection object would be a Bird Individual object, which would contain information collected about a specific bird observation.

  Data Collection objects are depicted in the model using this symbol: 

- *Analysis Objects*

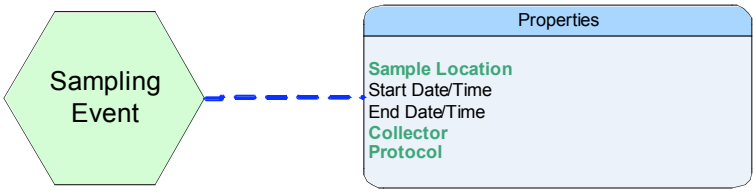
  Analysis Objects are objects that result from some sort of analysis; most likely an analysis performed using Data Collection and/or Reference objects as inputs. They are similar to Data Collection objects in that they are generally performed by the SECN as opposed to other outside agencies. For purposes of this conceptual model, analyses performed by other agencies and utilized by the SECN would be considered to be Reference Objects. A

Population object would be considered an example of an Analysis object, because it provides information that is obtained by analyzing and interpreting data from a selected set of Plant, Fish or Wildlife Individual objects.

Analysis objects are depicted in the model using this symbol:

Objects have certain attributes or properties that describe the characteristics of the object. Properties can be physical characteristics (size, color, age, etc.) or other non-physical characteristics, such as time frames, metadata, comparisons with standards, etc. Properties of an object are depicted in the model as a list of characteristics within a “Properties Box” that is attached to an object. Not all objects in the model have properties listed for them; some are included as placeholders or examples of the types of objects that may exist at that level of the model, and may be expanded in future versions of the model.

In some cases, the property of an object may actually be an object itself. This type of symbology is used when a particular object has an attribute that has its own component characteristics. For example, the Sampling Event object has a property named Protocol, which is used to record the protocol used during that sampling event. However, a protocol has many characteristics of its own (Name, Date, Author, Reference, etc.), so the model includes a Protocol object as well. Therefore, the Protocol property of the Sampling Event object is actually a reference to the Protocol object. This distinction is illustrated in the model by showing the property name in a bold font if it is meant to reference another object in the model:



Please note that there may be cases where properties of an object could be considered as separate objects, but they are not necessarily depicted that way in the model. Since this is a conceptual model, the intent is not to show all possible object components in the model; only key objects that illustrate the overall concepts are included. Therefore, only properties that reference another object currently included in the model are shown as “object properties” in the properties boxes; if new objects that further define the characteristics of an existing property are added to the model in the future, then those properties can be displayed as object properties at that time.

3.4. Inheritance

When developing or reviewing an object model, it is important to consider the concept of object inheritance. Inheritance deals with how properties are assigned from one object to the next. Objects of similar types are grouped in the model so that certain objects can be defined as special cases of a more general entity; through this grouping, objects share common properties within the group.

There are two types of objects used when displaying this type of hierarchy:

- Primary Objects

These objects, also known as Parent Objects, represent the highest level of an object hierarchy tree in the model, and are the most general types of objects in the business process. The attributes that these objects possess will be common to all objects within that branch of the hierarchy. These objects are shown in the model as hexagons, with associated properties.

- Sub-Objects
  Sub-Objects, also known as Child Objects, are objects that inherit the properties of their corresponding parent object(s), but also have additional properties that differ from those of other objects at the same level, making them distinct from the higher level objects. These objects are shown in the model as ovals, with inheritance lines connecting them back to their parent object. There may be multiple levels of sub-objects. Sub-objects generally include some properties, although the properties shown may not represent the complete list of properties for the associated object. In some cases, sub-objects are included simply as examples of the types of objects that may exist at that level, and do not include any properties. It should also be noted that the sub-objects shown for a particular parent object do not necessarily represent a complete listing of child objects that may exist at that level.

Through inheritance, sub-objects automatically inherit the properties of their parent object(s) in the model hierarchy. To illustrate this concept, consider the classic “Man’s Best Friend” example, as shown in Figure 5.

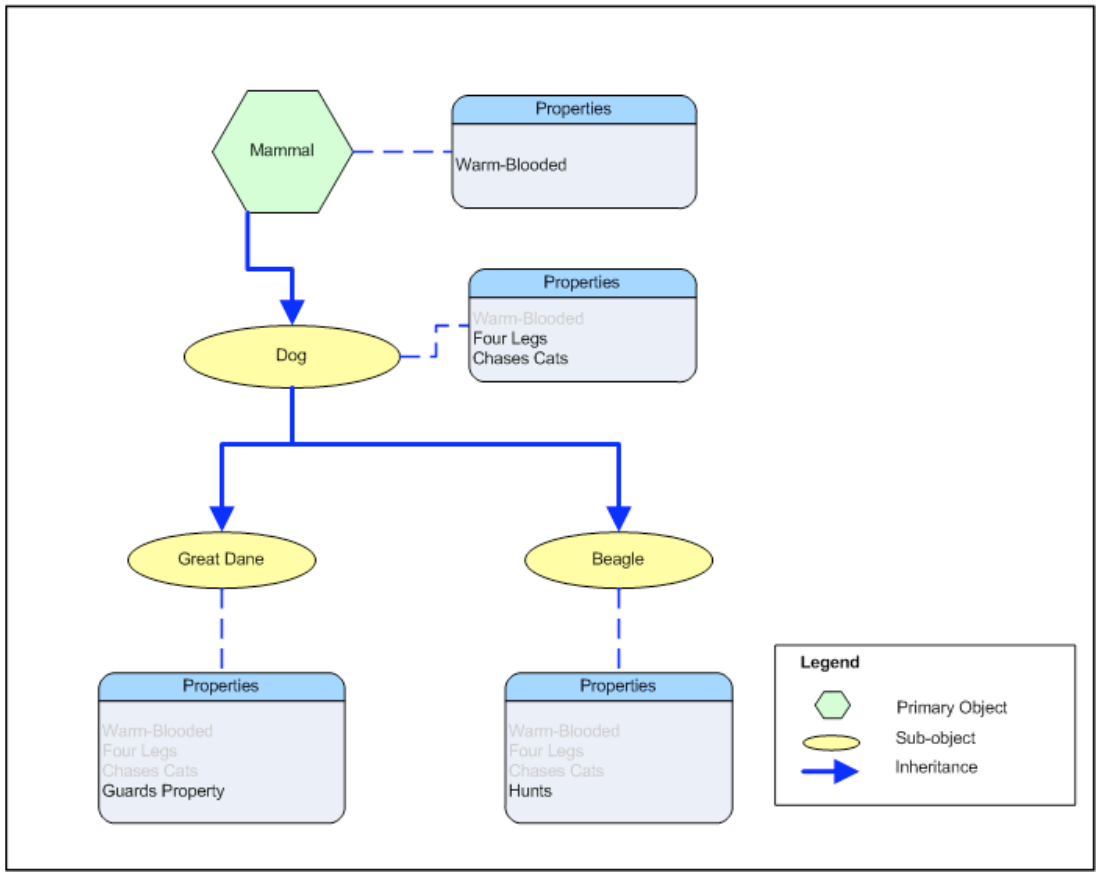


Figure 5. Example of object inheritance in a conceptual object model

In this example, the Mammal object is the highest-level object of the group, meaning that all objects in the group will inherit the properties of the mammal object (in this example, the only property assigned to a Mammal object is “Warm-Blooded”). The Dog object is a sub-object (child) of the Mammal (parent) object; all Dogs have the same common properties as Mammals (i.e., dogs are warm-blooded), but they also have additional properties that define them as Dogs (four legs, chases cats) and distinguish them from other mammals. Finally, at the lowest level of the diagram, each individual type of dog (Beagle, Great Dane, etc.) will inherit all of the properties of both the Mammal and Dog objects, but will have additional properties of their own that make them distinct from one another.

This same concept of inheritance has been applied to the development of the Natural Resources Inventory and Monitoring object model. In the model diagrams, each applicable sub-object inherits the properties of all of the objects above it in the hierarchy. The diagrams list the properties of a particular object; however, for simplicity, and to make the diagrams easier to read, only those properties that are new to an object at each level are actually listed with the object in the diagrams. Inheritance of properties from higher-level objects is implied throughout the object relationships, and should be kept in mind while reviewing these diagrams.

3.5. Aggregation

In an object model, aggregation is used to represent a compilation of objects, indicating that one object is created through a process of evaluating one or more properties from an aggregate collection of other objects. In the current version of the model, only one object is depicted as having an aggregation relationship with other objects – the Population object, which is created by evaluating aggregate properties of various Plant, Fish and Wildlife Individuals.

An aggregation relationship between objects is shown it the model using an aggregation line:

The diamond symbol at the head of the line indicates that the object attached to that end of the line is created from an aggregated collection of the objects attached to the other end of the line.

3.6. NPS Natural Resources Inventory and Monitoring Object Model

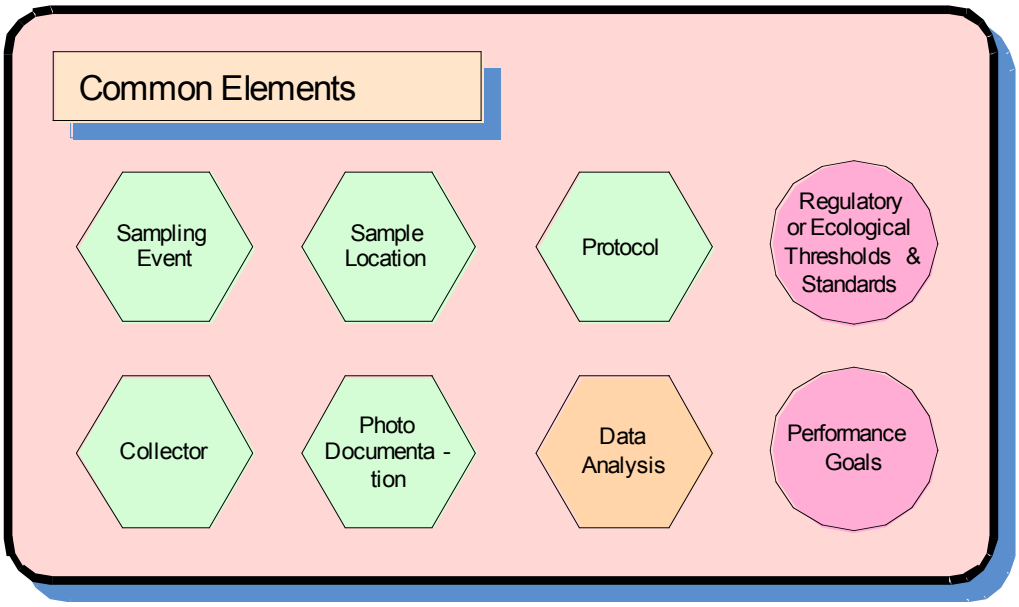
The following sections describe the various objects and components included in the Conceptual Object Model. The objects in the model have been grouped into categories that correspond to the major business areas within the Inventory and Monitoring Program; each category contains objects that are most closely associated with that category. This does not imply, however, that those objects will only apply to that category – objects can and will be related to objects in other categories. For example, the Air, Weather and Climate category contains an object for Sampling Event Weather; while this object will provide information that can be used for objects within that category, such as the Air Quality Analysis object, it will also be utilized by objects in other categories as well, whenever weather information needs to be collected for a sampling event.

In the following sections, model diagrams have been included that illustrate the objects included in each category; For purposes of this report, these figures have been simplified to show only the objects, the object type, and any inheritance or aggregation relationships that exist at the conceptual level between objects; the property boxes for each object have been removed, for clarity. For a listing of the properties associated with each object, please refer to Appendix 8, or to the full model diagram (thumbnail view appears in Appendix 9 and a large format presentation of the full model is included as an insert for the original version of this report).

When reviewing the properties of an object in the model diagram, the property type can be determined by the font used for that property. If a standard black font is used, then the property is

simply an attribute of that object. If a bold, colored font is used, then that property represents an object that can be found elsewhere in the model.

3.7. Common Elements



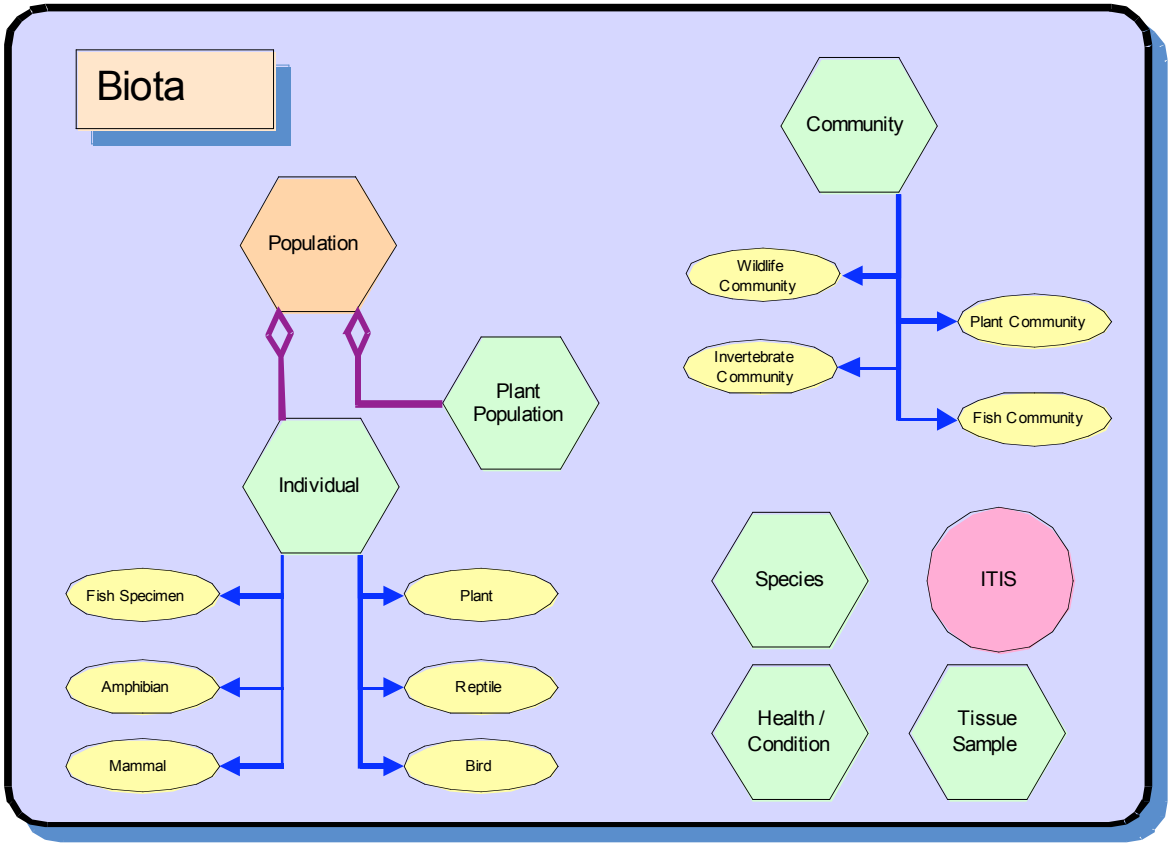
The Common Elements category contains objects that are used by many of the other categories. For purposes of simplicity and clarity in the model, rather than including copies of each of these objects within each of the categories that utilize them, they have been consolidated in this central category.

The objects in this category are primarily concerned with two types of activities: Sampling Events and Data Analysis. The Sampling Event object(s) are used to record information associated with activities performed when taking samples, including the date and time of the sample, its location, the protocol that was used, and who performed the work. These elements are common to any sampling event, and would apply to any sampling activities performed within the other object categories in the model.

Similarly, the Data Analysis object represents a component that is common to other analysis objects referenced within the model. This object is used to represent the various attributes that would be common to all analyses performed by the SECN, such as the spatial extent of the analysis (whether it is an entire park or a portion of a park), the time frame of the analysis, and comparison to various regulatory standards and goals. Though not specifically listed in other analysis objects throughout the model, the attributes associated with the Data Analysis object should be considered a part of each analysis performed using components of the model.

The properties associated with the Sampling Event object are representative examples of the types of properties that may be associated with this object. Other properties may be included, depending on the specific protocols used during the sampling event. The exact properties needed for this object will be determined during the database design phase of the development process.

3.8. Biota



This category includes objects that are used to record and track information related to Plants, Fish and Wildlife. There are three primary objects in this category:

- Individual
- Population
- Community

The Individual object is used to track information about plant, fish or wildlife individuals identified during sampling events or other incidental observations. This includes information such as species, age and gender, physical and behavioral characteristics, and detection method. There will likely be many sub-objects for the Individual object developed over time to support various reporting needs; several examples of sub-objects that were identified in the IPDs are illustrated in the model diagram.

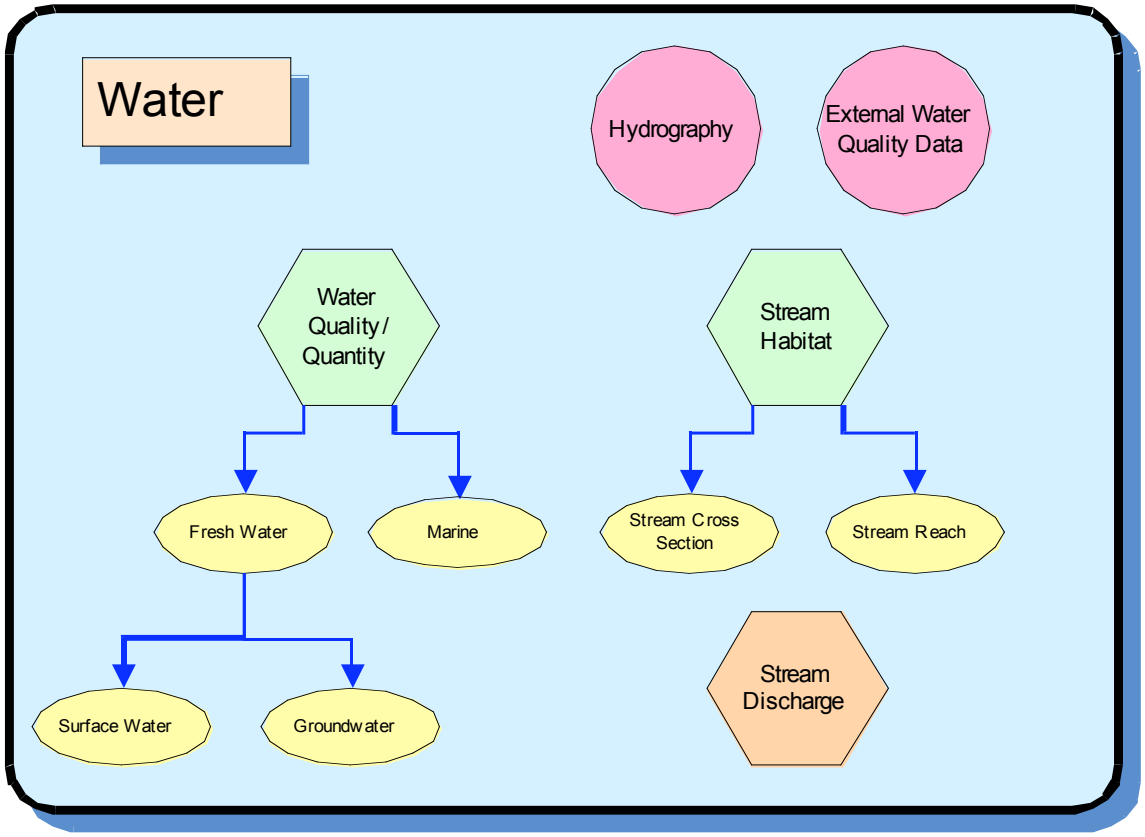
The Population object is an analysis object used to record estimates for a population as a whole, such as abundance estimates, productivity, sex ratio, age structure, and population dynamics. A Population object is derived by evaluating an aggregate sample of Individuals; therefore, it is shown as having an aggregation relationship with the Individuals object.

The Community object is used to record information about the species within a community, including species presence or absence, the number of species present and the total count for each species. This object consists of four sub-objects, Plant Community, Fish Community,

Wildlife Community, and Invertebrate Community, each representing the major community types monitored by the SECN.

Another object included in this category is the Species object, which is used in conjunction with the ITIS reference object to act as a repository for species information, including various local, state, and federal status values. The ITIS reference object will serve as the master list of species and taxonomic information whenever species data are collected. Also included are the Health/ Condition and Tissue Sample objects, which are related to the condition of an individual or specimen identified during the sampling process.

3.9. Water

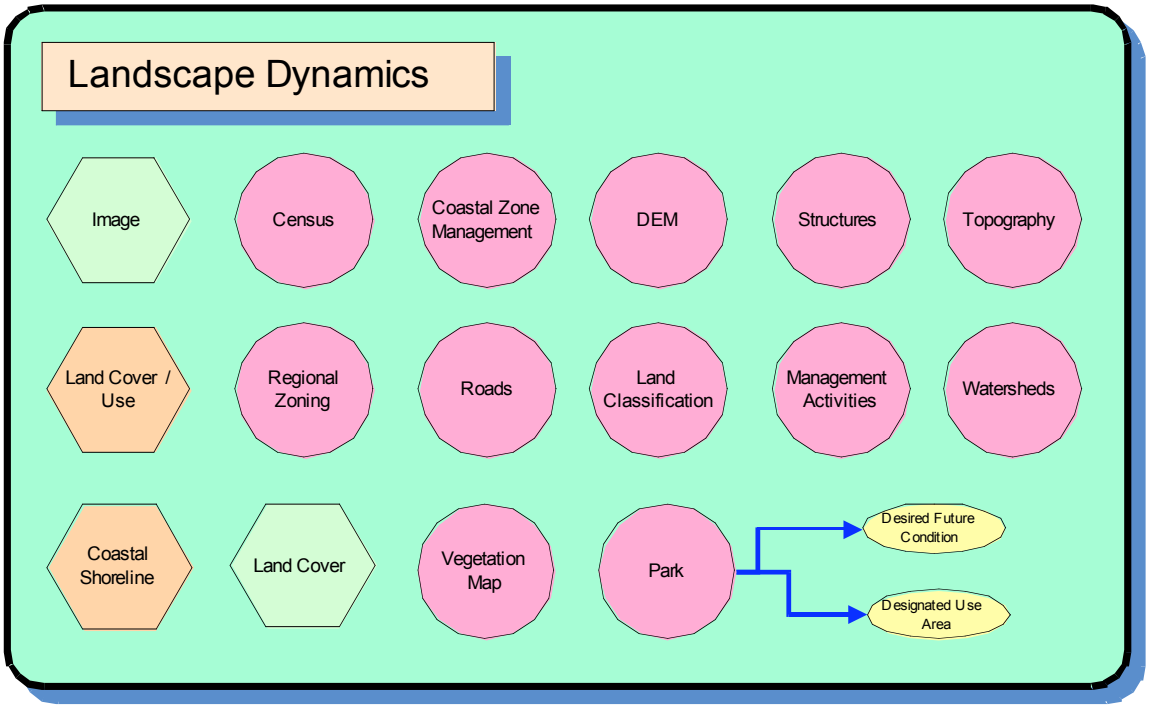


This category includes objects that are used to record and track information related to Water Quality, Quantity, and Stream Habitat.

The Water Quality/Quantity object tracks information collected during water quality sampling events, including chemical and physical characteristics and nutrient information about the water body being sampled. Sub-objects are included that divide the water body types into Fresh Water and Marine components, with the Fresh Water object further subdivided into Surface Water and Ground Water.

The Stream Habitat object includes information on such properties as water depth, discharge and debris; it also includes two sub-objects, for Stream Reach and Stream Cross Section information.

3.10. Landscape Dynamics

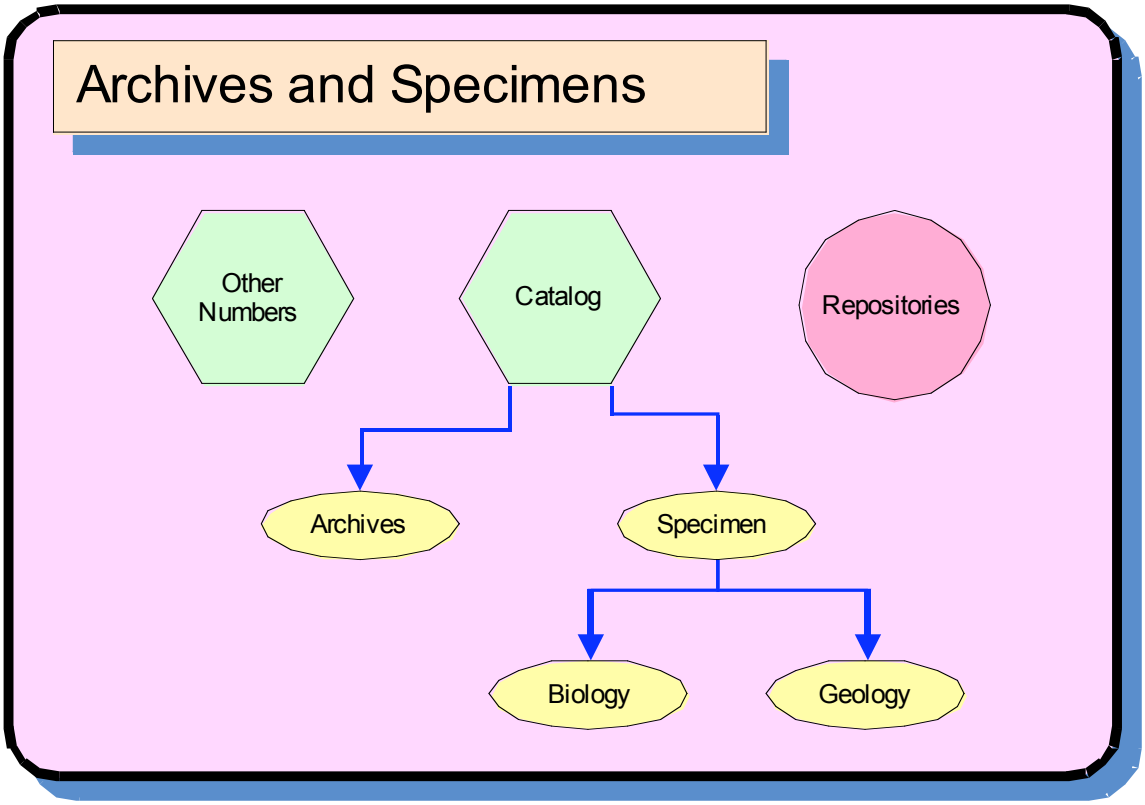


The Landscape Dynamics category includes objects related to tracking information about the physical makeup and condition of the land within a park. Much of this information is obtained from remote sensing data, so this group contains an Image object that tracks information about satellite images, aerial photographs, and other remote sensing images that are used as source data for other analysis objects.

Analysis objects in this category that make use of this imagery include the Land Cover/Use object, which is used to record information on various land classifications and ownership at given points in time, and the Coastal Shoreline object, which is used to record the location of the coastal shoreline at different points in time.

This category makes use of numerous reference objects that are maintained by a wide variety of different agencies and departments, both internal and external to the Park Service.

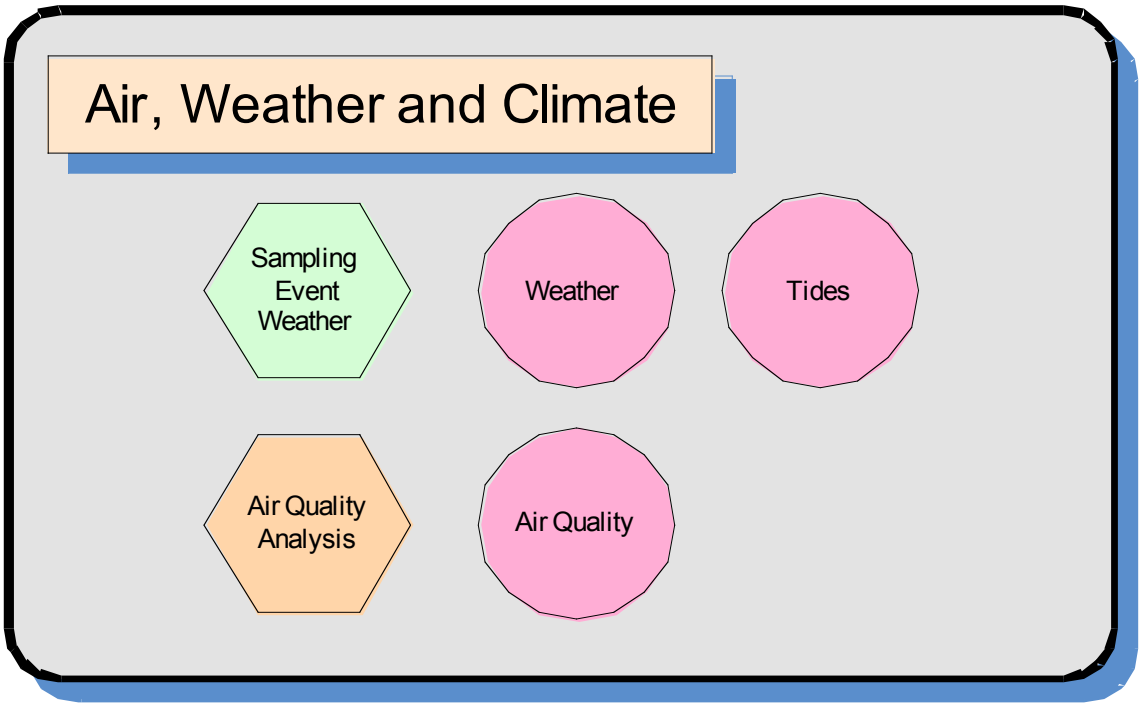
3.11. Archives and Specimens



This category includes objects that are used to record and track information related to cataloging archives and museum specimens. The Catalog object contains properties that are common to all archives and specimens, including items such as accession and catalog numbers, information about who identified, cataloged and logged the information as well as when it was recorded, the quantity of the item, and where it is stored.

The Catalog object contains two sub-objects. The Archive sub-object tracks information specific to archives, which includes such items as material, maintenance cycles, history, manufacturer information, measurements and descriptors. The Specimen sub-object tracks information common to all types of specimens, and includes items such as collection information, age, and location information. The Specimen sub-object also contains two additional sub-objects, Biology and Geology; these objects are used to track and record specimen attributes that are specific to each individual object type.

3.12. Air, Weather and Climate

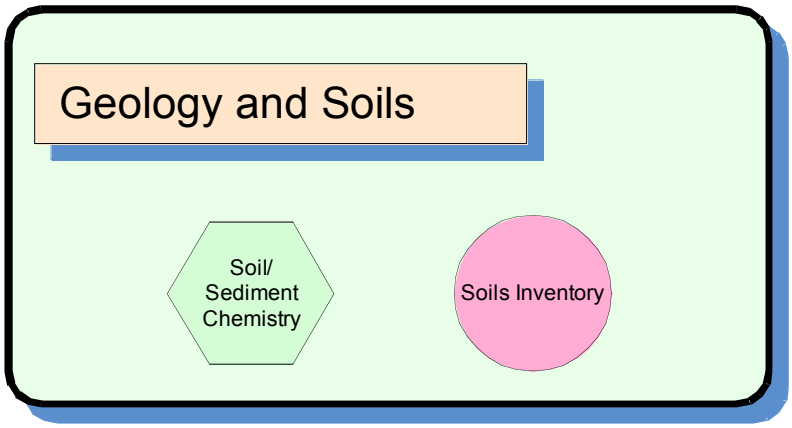


This category includes objects that are used to record and track information related to weather and climate. Most of these objects are used to support other types of data collection and analysis objects in other categories.

There are two types of weather-related objects in this category. The Sampling Event Weather object is used to record weather information that is specific to a particular sampling event, such as the temperature, precipitation and wind condition at the time a sample was taken. The Weather reference object is used to represent other types of weather data that may be obtained from other outside sources based on permanent weather stations, etc.

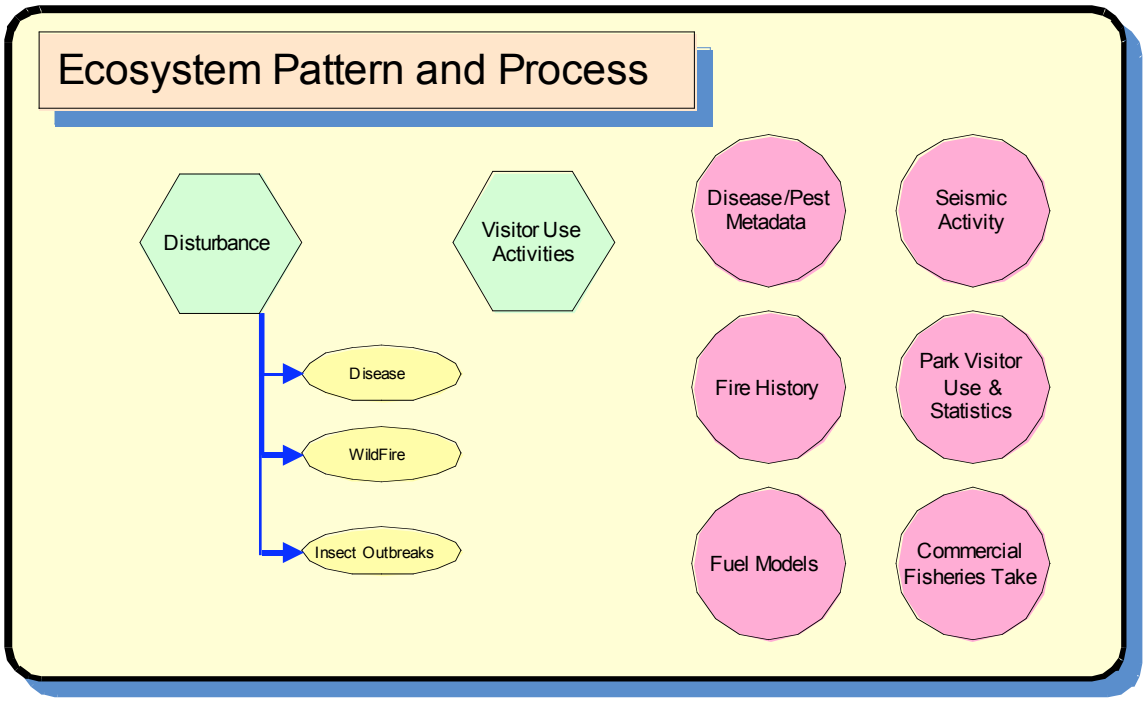
The Air Quality Analysis object is included because it represents data that cannot simply be derived by querying information from other objects. Performing an Air Quality analysis involves evaluating the results of an air quality modeling process, which itself uses information obtained from other objects as inputs. Because of this extra modeling step involved in deriving the Air Quality results, it is included specifically in the model as an analysis object. Other objects that could be considered similar to this type of object, such as Water Quality Analysis, for example, were not included in the model because they can be derived directly by querying the attributes of other object, without any additional modeling steps.

3.13. Geology and Soils



This category includes objects that are used to record and track information related to geology and soils. The Soil/Sediment Chemistry data collection object is used to track soil chemistry data obtained during sampling events, and includes such properties as salinity, moisture content, pollutants, and chemical concentrations. The Soils Inventory reference object is used to represent a soils layer that would be obtained from an outside agency.

3.14. Ecosystem Pattern and Process



This category includes objects that are used to record and track information related to natural and human activities that can impact the ecosystems within a park. The Disturbance object is used to track areas disturbed by various events; several sub-objects are included as examples of these types of events, including disease, insect outbreaks or wildfires. These are only examples of the types of disturbance events that may be included in the model, and there are potentially others that could be added in the future. This category also includes numerous reference objects related to such things as diseases, fire/fuels, and visitor use that can impact the ecosystem.

4. Strategic Application of INA Results

The information gained during the scoping workshops and the conceptual object model will serve as a foundation for future I&M development activities. Figure 6 illustrates how the object model can be used to help develop protocol specifications and procedures, and how new information gained during the protocol development process can be used to enhance detail within the model. Over time this will result in a model that reflects the needs of each of the protocols used by the network.

Following the protocol specification process, properties of objects that need to be collected, stored and managed for that protocol, as well as the relationships between these objects, can also be determined. Objects may behave differently for different protocols; for example, there may be certain properties of an object that are required for all protocols, while other properties may be required for some protocols but not for others. This information will be directly useful for designing and developing the physical database storage requirements necessary to support the information needs of the various protocols. In addition, the model will be used in conjunction with the protocol specifications and database design to develop future software applications that can be used to retrieve, store and manage data in the database.

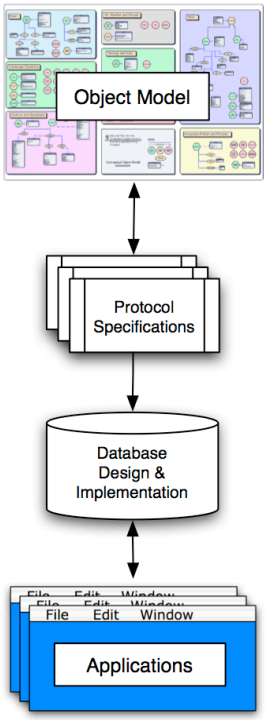


Figure 6. The object model is the strategic foundation for future development.

Several projects were identified as candidates for pilot implementation and demonstration of monitoring protocols. This section shows how the INA process and the information derived from it would be strategically applied to two significantly different pilot projects.

4.1. Fixed Station Water Quality Monitoring

One potential pilot project would involve the demonstration of water quality monitoring using extended deployment, fixed-station monitoring datasondes. Following the scoping workshops, analysis of the IPDs and workshop discussions several monitoring objectives were revealed that

identified the need for fixed station water quality monitoring. The relevant monitoring objectives and their associated IPDs are:

- Determine the status and trends of the quantity of freshwater entering estuarine and tidally-influenced ecosystems (IPD-0052)
- Determine status and trends of physiochemical variables in coastal waters (IPD-0051)
- Determine status and trends of nutrient concentrations in rivers, streams and lakes (IPD-0061)
- Determine status and trends of flow dynamics in rivers and streams (IPD-0063)

Table 1 shows the objects in the model that are cited by the IPD associated with each monitoring question. Appendix 8 lists the possible properties that have been identified during the INA for each of these objects. Following the principles shown in Figure 6, the IPDs and other future detailed protocol specifications for these monitoring objectives will reveal the particular properties for each object that are related to the protocol, as well as the relationships between objects within the protocol. For example, does the protocol require that Sampling Event Weather information be collected with each Sampling Event? If so, are all of the properties associated with a Sampling Event Weather object required for this protocol, or are some optional?

This process will define the database storage requirements necessary to support this protocol, which can then be incorporated with other protocols and captured by the database design. The IPDs and protocol specifications will also influence the application design and development process to help ensure that any applications developed are consistent with user expectations.

4.2. Shorebird Monitoring

Another potential pilot project is shorebird monitoring. The application of the INA results is similar to the previous example. The IPDs that would factor into shorebird monitoring are:

- Determine status, trends and composition of bird populations (IPD-0080)
- Determine the extent to which changes in habitat quality/availability affect birds (IPD-0081)
- Determine the extent to which visitor use of natural areas affects bird distribution and abundance within the park (IPD-0082)

Table 2 shows the objects cited by these three IPDs; the properties potentially associated with these objects are available in Appendix 8. Future protocol specification will refine the properties of these objects that are actually needed for these specific monitoring objectives and define the relationships between the objects as they relate to these protocols.

IPD ID	Title	Archives	Catalog	Collector	Data Analysis	External Water Quality Data	Fresh Water	Hydrography	Marine	Other Numbers	Park	Protocol	Regulatory or Ecological Thresholds & Standards	Repositories	Sample Location	Sampling Event	Sampling Event Weather	Stream Cross Section	Stream Discharge	Stream Reach	Surface Water	Tides	Water Quality/Quantity	Watersheds	Weather
NPS-SECN IPD-0051	Determine status and trend of physiochemical variables in coastal waters.	X	X		X	X		X	X	X	X	X	X	X	X	X	X					X		X	X
NPS-SECN IPD-0052	Determine the status and trends of the quantity of freshwater entering estuarine and tidally-influenced ecosystems.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X
NPS-SECN IPD-0061	Determine status and trends of physiochemical variables in rivers, streams and lakes.	X	X	X	X	X	X	X		X	X	X		X	X	X					X		X	X	
NPS-SECN IPD-0063	Determine status and trends of flow dynamics in rivers and streams.	X	X	X	X		X			X	X	X		X	X	X		X	X	X	X		X		

Table 1. Fixed Water Station Monitoring IPDs vs. Objects

IPD ID	Title	Archives	Bird	Catalog	Census	Collector	Data Analysis	Designated Use Area	Individual	ITIS	Land Classification	Land Cover/Use	Other Numbers	Park	Park Visitor Use & Statistics	Population	Protocol	Repositories	Sample Location	Sampling Event	Species	Visitor Use Activities
NPS-SECN IPD-0080	Determine status, trends and composition of bird populations.	X	X	X		X	X		X	X			X	X		X	X	X	X	X	X	
NPS-SECN IPD-0081	Determine the extent to which changes in habitat quality/availability affect birds.	X	X	X		X	X		X	X	X	X	X	X		X	X	X	X	X	X	
NPS-SECN IPD-0082	Determine the extent to which visitor use of natural areas affects bird distribution and abundance within the park.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 2. Shorebird Monitoring IPDs vs. Objects

5. Future Use of INA Results

Beyond developing the Conceptual Object Model, the following SECN activities will benefit from the breadth of information gathered in the INA and conceptual object modeling process.

5.1. Develop Case Studies

The proposed pilot projects for Fixed Station Water Quality and Shorebird Monitoring are outlined above. Pilot project implementation will allow the SECN to build case studies which will further develop project data requirements, analysis tools, and information product needs as data are collected in the field and used by park and network staff. The development of these case studies will also further enhance the object model, illustrating its utility and flexibility as a basis for future database and applications development - as well as assisting in future pilot project development. Case studies will allow us to clearly illustrate the utility of the object model – this is particularly important since we will probably not have taken the next steps towards developing the information management / decision support system by the time the draft of the DM plan is submitted for review. The two protocols indicated above are the furthest developed by the network and given how different in focus they are, they should serve as good examples of the utility of the object model.

5.2. Integration

The vital signs prioritization process used by the SECN is described in detail in Appendix 4 of the *Phase II SECN Vital Signs Monitoring Plan*[2]. In short, vital signs were assessed to determine the degree to which any given vital sign can be monitored with one or more other vital signs to synergistically meet additional monitoring objectives. The vital signs were selected to take maximum advantage of ongoing monitoring efforts being conducted by parks within the network and partnering agencies throughout the region – while meeting high-ranking monitoring objectives at all parks. In other words, the prioritized list of vital signs, if implemented sequentially from top priority down, provides the greatest amount of information to park resource managers by capitalizing on inter-relationships among vital signs and ongoing work in the parks and partners in this region.

This approach of developing an integrated monitoring program has been stressed in NPS policies (particularly NPS-75) and developed further during the SECN vital signs and data management planning process. The SECN has identified four levels of integration through its planning process:

- *Integration among vital signs*
  NPS-75 provides examples and suggestions for ways I&M program managers can view data from multiple vital signs to assess, model, predict, or interpret patterns in data across space and time.

- *Integration among parks*
  Integration of data from multiple parks into unified data sets allow for Network-wide roll-ups and within network comparisons.

- *Integration with partnering agencies*
  NPS-75 encourages integration with other agencies in two manners: through leveraging efforts with other agencies that monitor similar resources and by sharing data in standardized multi-agency formats (e.g. STORET).

[2] Available at http://www1.nature.nps.gov/im/units/secn/monitoring.htm

- *Programmatic Integration*
  Monitoring data can be analyzed and reported in many ways depending on the target audience and intended use of the data. Only by linking findings and predicted outcomes to proscribed actions can the Network's activities become fully integrated with other aspects of park management (e.g. planning, law enforcement, interpretation, and performance management).

In order to support the wide range of ecosystem parameters (vital signs) highlighted by the SECN object model and the aspects of integration described above, the SECN information management planning process was conducted in conjunction with the vital signs monitoring planning process via the information needs assessment. Because one of the goals of the I&M program is to base management decisions on scientific knowledge in a rapidly changing environment, it is incumbent on the SECN to develop tools that allow managers to make decisions on the most recent data available from as many related sources as possible. It is therefore the interpretation of the Southeast Coast Network that this necessitates the development of a single information management system that efficiently and cost-effectively allows for concurrent analysis of data from multiple vital signs and predictive modeling.

5.3. Implementation

Based on lessons learned from other networks and other Agency partners, the SECN data management program focuses on integration of information management systems both within the Network and between the Network and its partners. Data integration will allow the network to institutionalize quality data management practices across network parks and to build partnerships with external agencies. In addition, data integration among key stakeholders (including NPS, universities, state agencies, other federal agencies and non-profits) is and will continue to be critical to the success of the NPS Inventory and Monitoring Program. This single/integrated information management system will facilitate data integration and data quality locally and with partnering agencies, to the mutual benefit of NPS and other land management / natural resource agencies. The utilization of disparate, stand-alone databases to store and manage the Network's data resources will not be adequate to meet the SECN vital signs monitoring and information management goals.

6. Conclusions

> *Journey over all the universe in a map, without the expense and fatigue of traveling, without suffering the inconveniences of heat, cold, hunger, and thirst.*
>
> *— Miguel de Cervantes*

An Information Needs Assessment is a surveying journey that results in a map: the conceptual object model. The conceptual object model will evolve as it is enhanced through use and application while consistently offering value as a baseline tool. By undertaking the rigor of constructing the conceptual object model and applying it to future systems development, SECN's data management program has the opportunity to be spared many of the inconveniences that often arise in the design, development and deployment of information management systems, e.g. lack of data quality, slow systems development and failure to meet user expectations. Information quality, as demonstrated by utility, objectivity and integrity, is specifically called out as a federal goal for data quality; the conceptual object model is a proven technique for facilitating this goal.

The INA also provided considerable support for creating an integrated information management system for natural resources monitoring rather than multiple stand-alone databases that each address particular monitoring objectives. Such stand-alone systems are prone to significant disadvantages, especially over the long time periods that are critical for monitoring and analyzing trends in natural resources. Below is a comparison of the issues associated with the different approaches.

Disadvantages of stand-alone systems:	**Advantages of integrated system and lessons learned from INA:**
Lack of standard and uniform data collection and recording procedures	Data collection is included in the planning and protocol specification stages. Training for consistent data collection is paramount.
High potential for data quality problems, especially due to data redundancy	The conceptual object model provides a clear map for eliminating data redundancies and an integrated system encourages an implementation requiring singular storage of data. The protocol specifications should include data quality assurance procedures.
Inhospitable for data sharing and accessibility	An integrated system could be made widely accessible online. Partners could provide and access the networked data resource.
Difficult to learn and interpret results from disparate systems	Seldom are single parameters sufficient to conduct data analysis. Many ecological studies require the incorporation of data from multiple fields of study during analysis and interpretation (e.g. water quality data, weather data, and site condition data). In addition, user acceptance is critical for the success of any information system and the conceptual object model provides the logical basis for a system that matches real-world needs. Users can learn a small set of reporting and interpretive techniques on an integrated system that will transfer across multiple monitoring scenarios.

Disadvantages of stand-alone systems:	Advantages of integrated system and lessons learned from INA:
Extra long-term costs associated with all of the above	An integrated system may require a longer planning process but applying a conceptual object model has been proven to improve systems design, accelerate development and lead to smoother deployment of applications in the long run.

Stewardship of natural resources is widely accepted as an important responsibility within the National Park Service. The INA process illuminates data stewardship as a portion of the responsibility for natural resources. Focused leadership and the following ongoing efforts will be required to build a strong data stewardship program:

- Continue to review best practices in the field.
- Establish and reward data stewardship as a value within the region.
- Recognize that data stewardship begins with standards and follows a continuum from field collection to validation to committal to the corporate database.
- Monitor database maintenance.
- Track accountability for data (possibly using meta-data).
- Provide appropriate software tools for promoting consistent data stewardship practices.

Ultimately, a successful inventory and monitoring program is challenged with preserving the data of the past while accommodating the dynamic demands of the present and the future. This INA has resulted in a structured, yet adaptable, conceptual object model that provides a solid foundation for meeting those challenges.

> *It is change, continuing change, inevitable change, that is the dominant factor in society today. No sensible decision can be made any longer without taking into account not only the world as it is, but the world as it will be.*
>
> *— Isaac Asimov*

7. Appendices

Appendix 1. Workshop Participants

Remote Sensing May 4-5, 2005	
Crista Carroll	NPS SERO, Regional GIS Coordinator
Joe DeVivo	Coordinator, NPS Southeast Coast Network, Inventory & Monitoring Program
Rebecca L. Dodge	University of West Georgia, Director GLOBE Partnership Program
Jim Ebert	Biologist, NPS Outer Banks Group
Liz Kramer	University of Georgia, Director Natural Resource Spatial Analysis Laboratory
Marguerite Madden	Director of Center for Remote Sensing and Mapping Science / Associate Professor, Department of Geography, University of Georgia
Sara McCort	Data Management Technician, NPS SECN I&M
Christina Wright	Science Information Specialist/Ecologist, National Park Service, Southeast Coast Network

Estuaries & Tidal Creeks June 22-23, 2005	
Merryl Alber	Associate Professor, University of Georgia, Department of Marine Sciences
Richard Bryant	Chief of Resources Stewardships and Partnerships, Timucuan Ecological and Historic Preserve
Eva DiDonato	Aquatic Ecologist/Water Quality Specialist, National Park Service, Southeast Coast Network
Virginia Engle	Ecologist, US Environmental Protection Agency, Gulf Ecology Division
Fred Holland	Director, National Oceanic and Atmospheric Administration, Hollings Marine Laboratory
Kristen Keteles	Coastal Resource Analyst, NPS Information Resource Division, Texas A&M University
Michael Mallin	Associate Professor, University of North Carolina at Wilmington, Center for Marine Science
Denise Sanger	Senior Scientist, SC Department of Health and Environmental Control, Office of Ocean and Coastal Resource Management
Erik Smith	Research Assistant Professor / Research Coordinator, North Inlet - Winyah Bay NERR, Baruch Marine Field Laboratory / University of South Carolina
Robert Van Dolah	Director, Marine Resources Research Institute
Elizabeth Wenner	Senior Marine Scientist and Principal Investigator, Marine Resources Research Institute
Joe DeVivo	Coordinator, NPS Southeast Coast Network, Inventory & Monitoring Program
Christina Wright	Science Information Specialist/Ecologist, NPS Southeast Coast Network

Rivers & Streams June 29-20, 2005	
David Chestnut	SC Department of Health and Environmental Control
Alan Covich	University of Georgia, College of Environment and Design, Institute of Ecology
Melinda Dalton	US Geological Survey
Will Graf	University of South Carolina, Department of Geography
Bill Huslander	Integrated Resource Program Manager, National Park Service, Congaree National Park
Jim Long	Fisheries Biologist, National Park Service, Southeast Region
Bill Marshall	South Carolina Department of Natural Resources
Kathy Methier	GA Department of Natural Resources Environmental Protection Division
Theresa Thom	US Fish and Wildlife Service, SCEP from University of Georgia
Mork Winn	Georgia Department of Natural Resources, Environmental Protection Division
Joe DeVivo	Coordinator, NPS Southeast Coast Network, Inventory & Monitoring Program
Christina Wright	Science Information Specialist/Ecologist, NPS Southeast Coast Network

Vegetation July 20-21, 2005	
Michael Byrne	Wildlife Ecologist, NPS – SECN
Dean Gettinger	NPS –Fire GIS Specialist, Southeast Region
Cherry Green	NPS – Wetland Ecologist, SERO
Kevin Hiers	Fire Ecologist, TNC - GA
Michelle Mitchell	Trail Program Manager, USFS – FL
Milo Pyne	Senior Regional Ecologist, Southern United States, NatureServe
Michael Rikard	Chief of Natural Resources, CALO, NPS
J P Schmidt	UGA, Institute of Ecology
Martha Segura	Coordinator, NPS Gulf Coast Network, Inventory and Monitoring Program
Joe DeVivo	Coordinator, NPS Southeast Coast Network, Inventory & Monitoring Program
Christina Wright	Science Information Specialist/Ecologist, National Park Service, Southeast Coast Network

Wildlife September 14-15, 2005	
Kelly Bettinger	University of Georgia
Michael Byrne	Wildlife Ecologist, NPS – SECN
Kate Dahl-Kearney	Museum Specialist, NPS - Southeast Coast Network
Joe DeVivo	Coordinator, NPS Southeast Coast Network, Inventory & Monitoring Program
Stephen Earsom	US Fish and Wildlife Service
John Fry	NPS - Cumberland Island National Seashore
Clay George	GA-DNR Wildlife Resources Division, Nongame-Endangered Wildlife Program
John Jensen	GA-DNR Wildlife Resources Division, Nongame-Endangered Wildlife Program
Tim Keyes	GA-DNR Wildlife Resources Division, Nongame-Endangered Wildlife Program
Susan Loeb	USDA, Forest Service, T&E Wildlife and Plant Research Unit
Stefani Melvin	US Fish and Wildlife Service
Tim Mersmann	USDA, Forest Service
Joe Meyers	USGS Patuxent Wildlife Research Center
Allan O'Connell	USGS Patuxent Wildlife Research Center
Jim Ozier	GA-DNR Wildlife Resources Division, Nongame-Endangered Wildlife Program
Gary Peters	USDA, Forest Service - Francis Marion and Sumter National Forests
Todd Schneider	GA-DNR Wildlife Resources Division, Nongame-Endangered Wildlife Program
Linda Weir	USGS Patuxent Wildlife Research Center – North American Amphibian Monitoring Program
Joe DeVivo	Coordinator, NPS Southeast Coast Network, Inventory & Monitoring Program
Christina Wright	Science Information Specialist/Ecologist, NPS - Southeast Coast Network

Appendix 2. Project Web Site

The project web site will remain online indefinitely to provide access to this report and other documents from the Information Needs Assessment. The address for the site is:

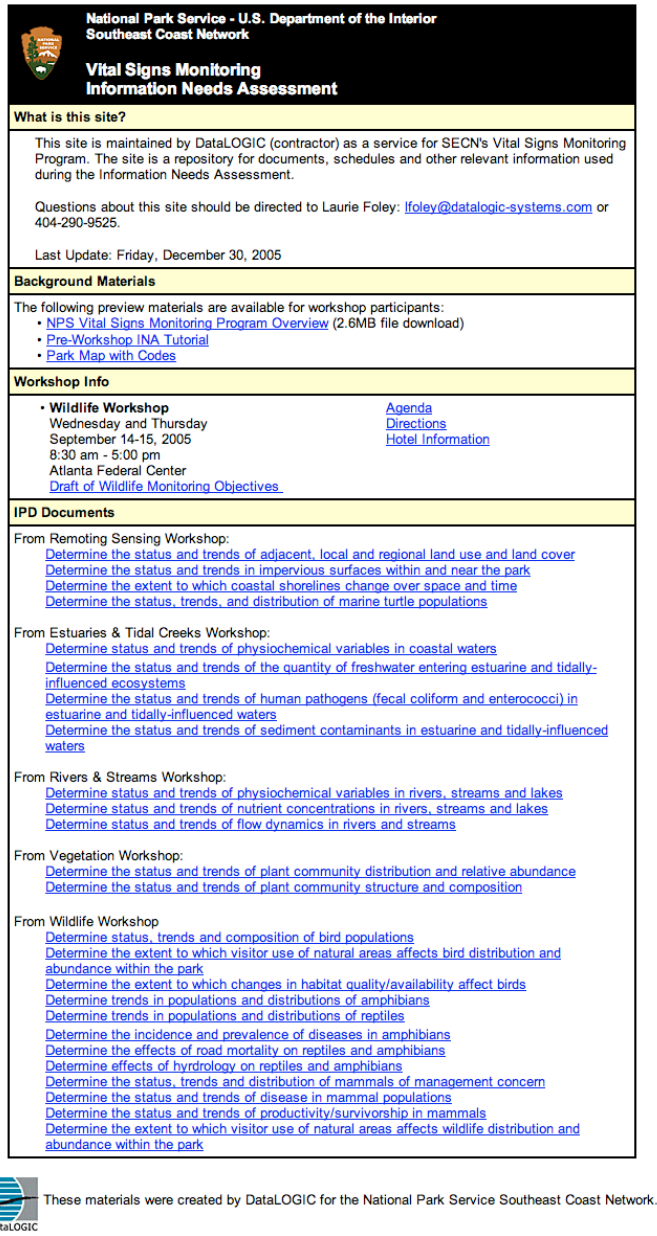
`http://www.datalogic-systems.com/nps/secn/`

It is password-protected for privacy. Access is available via:

`username: npssecn`

`password: vitalsigns`

Below is a sample view of the site as it appeared during a scoping workshop:



National Park Service - U.S. Department of the Interior
Southeast Coast Network

Vital Signs Monitoring
Information Needs Assessment

What is this site?

This site is maintained by DataLOGIC (contractor) as a service for SECN's Vital Signs Monitoring Program. The site is a repository for documents, schedules and other relevant information used during the Information Needs Assessment.

Questions about this site should be directed to Laurie Foley: lfoley@datalogic-systems.com or 404-290-9525.

Last Update: Friday, December 30, 2005

Background Materials

The following preview materials are available for workshop participants:
- NPS Vital Signs Monitoring Program Overview (2.6MB file download)
- Pre-Workshop INA Tutorial
- Park Map with Codes

Workshop Info

- **Wildlife Workshop**
  Wednesday and Thursday
  September 14-15, 2005
  8:30 am - 5:00 pm
  Atlanta Federal Center
  Draft of Wildlife Monitoring Objectives

Agenda
Directions
Hotel Information

IPD Documents

From Remoting Sensing Workshop:
- Determine the status and trends of adjacent, local and regional land use and land cover
- Determine the status and trends in impervious surfaces within and near the park
- Determine the extent to which coastal shorelines change over space and time
- Determine the status, trends, and distribution of marine turtle populations

From Estuaries & Tidal Creeks Workshop:
- Determine status and trends of physiochemical variables in coastal waters
- Determine the status and trends of the quantity of freshwater entering estuarine and tidally-influenced ecosystems
- Determine the status and trends of human pathogens (fecal coliform and enterococci) in estuarine and tidally-influenced waters
- Determine the status and trends of sediment contaminants in estuarine and tidally-influenced waters

From Rivers & Streams Workshop:
- Determine status and trends of physiochemical variables in rivers, streams and lakes
- Determine status and trends of nutrient concentrations in rivers, streams and lakes
- Determine status and trends of flow dynamics in rivers and streams

From Vegetation Workshop:
- Determine the status and trends of plant community distribution and relative abundance
- Determine the status and trends of plant community structure and composition

From Wildlife Workshop
- Determine status, trends and composition of bird populations
- Determine the extent to which visitor use of natural areas affects bird distribution and abundance within the park
- Determine the extent to which changes in habitat quality/availability affect birds
- Determine trends in populations and distributions of amphibians
- Determine trends in populations and distributions of reptiles
- Determine the incidence and prevalence of diseases in amphibians
- Determine the effects of road mortality on reptiles and amphibians
- Determine effects of hyrdrology on reptiles and amphibians
- Determine the status, trends and distribution of mammals of management concern
- Determine the status and trends of disease in mammal populations
- Determine the status and trends of productivity/survivorship in mammals
- Determine the extent to which visitor use of natural areas affects wildlife distribution and abundance within the park

DataLOGIC These materials were created by DataLOGIC for the National Park Service Southeast Coast Network.

Appendix 3. Sample Agenda

This example is from the wildlife scoping workshop; other workshops followed a similar agenda.

Southeast Coast Network Wildlife Scoping Workshop Agenda
14 and 15 September, 2005
Atlanta, GA

Context and Background:

The National Park Service is currently developing long-term ecological monitoring programs for National Parks with significant natural resources. The SECN includes seventeen national parks extending along the Atlantic coast from the North Carolina-Virginia border south to Cape Canaveral, Florida and inland as far as Atlanta, Georgia and the Alabama Coastal Plain. At this meeting, specific monitoring objectives will be reviewed and discussed, including the following topic areas: (1) long-term status and trends in reptiles, amphibians, mammals, birds, and non-native/invasive animals; and (2) wildlife diseases. Participants will form working groups to develop protocol options in a framework that includes the data requirements, appropriate survey design, cost estimates, and project outputs necessary to meet our monitoring objectives and support natural resource and information management. Potential partnerships and data integration with other programs (e.g., statewide, regional) will also be discussed.

Meeting Objectives and Desired Outcomes:

1. This workshop will provide an opportunity to familiarize participants with the Inventory and Monitoring Program, Southeast Coast Network, vital-signs selection process, and long-term monitoring objectives related to wildlife.
2. Identify/develop data requirements, appropriate survey designs, cost estimates, project outputs and potential partnerships necessary to meet our selected monitoring objectives. The result of this workshop will be protocol options set forth in a template that includes the resultant information products that will serve as a guide for monitoring and support natural resource and information management.
3. Develop pilot project protocols in support of network monitoring objectives.

September 14th:

8:30 AM	Welcome and Introductions
9:00 AM	Introduction and overview of the Inventory and Monitoring Program
10:00 AM	Break
10:15 AM	Overview of workshop process and objectives
10:45 AM	Discuss and prioritize monitoring objectives
12:00 PM	Lunch
1:00 PM	Working Group Session I
2:30 PM	Break
2:45 PM	Working Group Session II
4:45 PM	Progress Report from working groups
5:00 PM	Close

September 15th:

8:30 AM	Working Group Session III
10:00 AM	Break
10:15 AM	Working Group Session IV
12:00 PM	Lunch
1:15 PM	Review and wrap-up working sessions (if necessary)
2:00 PM	Break
2:15 PM	Brainstorm pilot project protocols in support of monitoring objectives
4:45 PM	Wrap-up
5:00 PM	Close

Appendix 4. Information Product Description Template

1. Title
Short, descriptive title in the format of the long term monitoring objective.

2. Narrative Summary
In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

3. Sampling Design Elements
Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

4. Data / information required (input / collection)
Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

5. Steps required to make the information product (process / analysis)
Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

6. Map Requirements (output)
Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

7. Tabular data Requirements (output)
Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

8. Chart or Graphical Display of Results (output)
Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

9. Frequency of creation and use
Please describe how often this output should be created and how often it will be used.

10. Legal or Policy Issues
Note any legal or policy considerations that impact the creation or use of this information product.

11. Cost Estimate
Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

12. What Else?
Please include any other details that would impact the creation or use of this information product.

Appendix 5. IPD Index

IPD ID	Title
NPS-SECN IPD-0014	Determine the status and trends of adjacent, local and regional land use and land cover
NPS-SECN IPD-0022	Determine the status, trends and distribution of marine turtle populations
NPS-SECN IPD-0044	Determine the extent to which coastal shorelines change over space and time
NPS-SECN IPD-0045	Determine the status and trends in impervious surfaces within and near the park
NPS-SECN IPD-0051	Determine status and trend of physiochemical variables in coastal waters
NPS-SECN IPD-0052	Determine the status and trends of the quantity of freshwater entering estuarine and tidally-influenced ecosystems
NPS-SECN IPD-0053	Determine the status and trends of human pathogens (fecal coliform and enterococci) in estuarine and tidally-influenced waters
NPS-SECN IPD-0054	Determine the status and trends of sediment contaminants in estuarine and tidally-influenced waters
NPS-SECN IPD-0061	Determine status and trends of physiochemical variables in rivers, streams and lakes
NPS-SECN IPD-0062	Determine status and trends of nutrient concentrations in rivers, streams and lakes
NPS-SECN IPD-0063	Determine status and trends of flow dynamics in rivers and streams
NPS-SECN IPD-0071	Determine the status and trends of plant community distribution and relative abundance
NPS-SECN IPD-0072	Determine the status and trends of plant community structure and composition
NPS-SECN IPD-0080	Determine status, trends and composition of bird populations
NPS-SECN IPD-0081	Determine the extent to which changes in habitat quality/availability affect birds
NPS-SECN IPD-0082	Determine the extent to which visitor use of natural areas affects bird distribution and abundance within the park
NPS-SECN IPD-0083	Determine the incidence and prevalence of diseases in amphibians
NPS-SECN IPD-0084	Determine the effects of road mortality on reptiles and amphibians
NPS-SECN IPD-0085	Determine effects of hydrology on reptiles and amphibians
NPS-SECN IPD-0086	Determine trends in populations and distributions of reptiles
NPS-SECN IPD-0087	Determine trends in populations and distributions of amphibians
NPS-SECN IPD-0088	Determine the status, trends and distribution of mammals of management concern
NPS-SECN IPD-0090	Determine the status and trends of disease in mammal populations
NPS-SECN IPD-0091	Determine the extent to which visitor use of natural areas affects wildlife distribution and abundance within the park
NPS-SECN IPD-0101	Determine the status and trends in groundwater quality and quantity
NPS-SECN IPD-0102	Determine the status and trends in air quality
NPS-SECN IPD-0103	Determine the status and trends in soil chemistry
NPS-SECN IPD-0104	Determine the status and trends in subsidence
NPS-SECN IPD-0105	Determine the trends in natural disturbance regimes
NPS-SECN IPD-0106	Determine the status and trends in wildlife communities
NPS-SECN IPD-0107	Determine the status and trends in fish communities
NPS-SECN IPD-0108	Determine the status and trends in commercial fisheries take
NPS-SECN IPD-0109	Determine the status and trends in aquatic invertebrate communities
NPS-SECN IPD-0110	Determine the status and trends of stream habitats
NPS-SECN IPD-0111	Determine the spatial and temporal extent of management activities

Note: IPDs #101-111 are currently placeholder titles. The objects that are associated with their stated monitoring objectives were specified for inclusion in the object model.

Appendix 6. IPD Catalog

Appendix 5 lists the index for this catalog.

This appendix contains the information product description documents created during the scoping workshops. The appendix starts on the next page.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status and trends of adjacent, local and regional land use and land cover.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long term monitoring program.

One of the goals of the National Park Service Inventory and Monitoring Program is to initiate long-term monitoring within parks with significant natural resources. National Park Service units are often surrounded by conflicting land uses which significantly influence the status of park resources. In order to successfully monitor the negative consequences of land use activities, the National Park Service must first understand how adjacent land use activities are changing and in turn, how those changes may impact management of park resources.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Watershed, regional, or larger extent would typically be the area of interest for a landscape dynamics level monitoring question. Scale would typically be 1:100,000 for satellite based land use/land cover. Projected land use data that is available from National Land Cover Data Set is updated every 10 years. Image availability and timing of image acquisition will always be the bottleneck in this type of monitoring project.

Input is likely to be of varying resolution and accuracy. Minimum 80% thematic accuracy assessment is desirable.

4. Data/Information required to make the information product (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources as applicable.

1) Satellite imagery or aerial photography to determine land cover / land use.

2) Helpful ancillary data might include: management activities, zoning, census data, fire or fire fuels analyses, streams / water body, vegetation maps, planimetric data, roads, etc.

***Data sources:* NLCD, county and state government, US Census, NHD data, research institutions (veg. and fire), USGS.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 7 would be used to create the information product. Please be as specific as possible.

1) Define area of interest by determining the region of importance for each park (e.g. watershed or region). Land use change determination will be a complete census throughout the region of interest as determined here.

2) Define time period of interest - influenced by specific monitoring objective being answered and data (aerial photo, satellite imagery, etc.) availability over time.

3) Develop/define the categories of land use being considered (e.g. agricultural, forest, urban, etc.). Commonly used is the land use and land cover classification developed by Anderson et al. 1976.

4) Define the scale (e.g. National Land Cover Data is 30 m pixel size). Again, this will be limited by the data availability for the time period of interest.

5) Develop/define the data summary and analysis techniques - both for assigning original land use/land cover categories as well as change detection analyses. There are several methodologies available - e.g. land use/land cover classification - Madden et al. 1999, Welch et al. 1999, Madden 2003.

6) Gather / collect historical and current imagery and maps to be used for classification.

7) Assign land use classes determined above to each data layer. This analysis will be completed for past and current time periods.

8) Quantify changes in land use using methods defined above.

9) Perform an accuracy assessment

Note: National Land Cover Data Set Methodology is based on Palmer et al. 2002

***Partnership opportunities:* MRLC, Georgia GAP, SE GAP, adjacent land management agencies, NARSAL, CRSMS.

6. Map Requirements (output)

Please include details like scale, extent, layers, and map unit criteria, if possible.

Map Description: Adjacent land use/land cover

Scale:	Large: (1:100,000 to 1:24,000)
Extent:	Region
Layers:	Current land use, Habitat type, Park outline, Projected land use (5-yr. intervals)

Regional extent means area of interest for this map.

Scale would typically be 1:100,000 for satellite based land use/land cover.

Projected land use data that is available from National Land Cover Data Set is updated every 10 years.

Displayed layers would depend on actual inquiry.

7. Tabular Data Requirements (output)

Details of any information that will be presented in the form of a report, list, or table, including headers and typical data entries.

Table should include land use/cover classes determined in project planning stage with an indication of the proportion (%) of land covered by each land use/cover class for each time period as well as the percent change for each land use/cover class over time.

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Proportion of various land uses (by category) in adjacent lands.

Graphical display of tabular output, too. There is great potential for interactive digital map products from this type of product.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

This product would likely be used on a project basis or as needed.

There are many potential users of this product, including: Superintendents, WASO, Special Interest Groups, Scientists (Regional, others), Partner Agencies, Natural Resource Managers, Law Enforcement, Lands and Planning, Interpretation, General Public, Compliance Coordinators, Network Staff, Cultural Resource Managers, and Maintenance.

Frequency of creation would depend upon the information needed from a land use / land cover change analysis. However, it is likely to be on a 5-10 year update schedule. For example, projected land use data that is available from National Land Cover Data Set is updated every 10 years. Image availability and timing of image acquisition will always be the bottleneck in this type of monitoring project.

10. Cost Estimate

Please describe the costs of producing the product with the methods described above. Please include time spent and other resources required, if known.

National Land Cover Data Set is available and freely distributed.

If outsourced, cost is approximately $20,000 per area of interest.

11. What Else?

Please include any other details that would impact the creation or use of this information product.

Of primary concern to parks are effects of changing landscape dynamics on water resources, air resources, and effects on park resources in general. Data in these analyses can be used to model expected changes and to interpret those changes identified

through modeling other vital signs.

Land use dynamics were identified in all conceptual models as a significant driver of ecosystem processes. The types and changes among land use and land cover types within the general landscape are expected to gain in significance in the future as human population growth and associated external development pressures grow.

Biggest challenge is maintaining access to CURRENT land use/land cover data.

This type of project is very cost effective and uses reliable data with the potential for multiple outputs and analyses. In addition, there is great opportunity for partnering with other agencies.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status, trends, and distribution of marine turtle populations

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long term monitoring program.

All of the marine turtles found in SECN Parks have some federal designation as either Threatened or Endangered. Extensive efforts are dedicated to nest survey and protection from predators and human disturbance. Although primary focus of management is on nesting habitat, marine turtles also require marine conditions suitable for survival.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

4. Data/Information required to make the information product (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources as applicable.

Species data – including occurrence, location, population structure, productivity and abundance data of the following: Loggerhead Sea Turtle (*Caretta caretta*) Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) Hawksbill Sea Turtle (*Eretmochelys imbricata*) Green Sea Turtle (*Chelonia mydas*) Leatherback Sea Turtle (*Dermochelys coriacea*).

Human use or visitor use, as well as predator data may be important for analyzing nest success.

Also, it would be good to know the areal extent and spatial distribution of acceptable nesting habitat within the study area or area of interest.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 7 would be used to create the information product. Please be as specific as possible.

Process to produce population distribution map:
1. Define the area of interest.
2. Import data layers from Data Requirements section including seasonal field inventory data, plot data, and base map.
3. Summarize statistical data graphically if desired.
4. Final map will include scale, date, source, north arrow, title, disclaimer, and legend.

6. Map Requirements (output)

Please include details like scale, extent, layers, and map unit criteria, if possible.

Map Description: Sea turtle nesting distribution
Scale: 1:24,000 or better

Extent: Park

Data Layers: Park outline, delineated habitat types, sea turtle nesting distribution, visitor impact sites, visitor use areas. It would be desirable to have contour lines displayed on map.

7. Tabular Data Requirements (output)

Details of any information that will be presented in the form of a report, list, or table, including headers and typical data entries.

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Abundance over time

Abundance by species

Productivity by species

Productivity over time

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Breeding populations are seasonal and information about them would be used daily in season.

Depending on the use, these products could be created daily to weekly throughout the breeding season.

There are many potential users of these products: Scientists (Regional, others), Partner Agencies, Natural Resource Managers, Lands and Planning, Interpretation, General Public, Compliance Coordinators, Network Staff, Maintenance, and Superintendents.

11. Cost Estimate

Please describe the costs of producing the product using the methods described above. Please include time spent and or other resources required.

Costs would include: field personnel recording GPS locations and GIS personnel time and equipment. Overall it would be desirable to have in-house GIS support as the costs for this project will rise quickly if outsourced given the need for timely analysis. In general, current mapping capabilities are limited by lack of resources (time and trained personnel).

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Because these species have some level of protected status, high quality data on the status and trends of marine turtle populations are necessary for scientific defensibility. In addition, this information must be quantifiable and the study must be repeatable.

Ideal outcomes – these data could lead to the protection previous nest sites in advance of next season.

These products are also useful in public information. In other words, this would be useful information to actively promote turtle protection through public relations, proactive communication with legislators, and park's web site.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the extent to which coastal shorelines change over space and time.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long term monitoring program.

Shorelines are highly dynamic systems subject to natural erosion and accretion and storm events. Shoreline is also impacted by human activity, including development and dredging. Information products about shoreline change are necessary for planning, management and understanding the impacts of natural processes.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

4. Data/Information required to make the information product (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources as applicable.

1) Aerial Photography – photo series from time periods of interest

Note: Must be sure to capture time of data acquisition and normalize different datasets based on tide level. The geometric accuracy of the source imagery is critical to the validity of the shoreline extraction. Shoreline changes may actually be less than the horizontal accuracy of the source data.

2) Ancillary data – helpful for modeling / predictive applications related to shoreline change:

Extreme Disturbance Events (e.g. Floods, Hurricanes, Tornadoes)
Coastal management activities and zoning
Coastal / oceanographic features and processes
Digital Elevation Model
Water bodies (e.g. marine, lakes, streams, rivers)
Soil data (texture, type, organic material, thickness)
Visitor use (location, magnitude, type of use)
Local population demography
Impervious surface analysis

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 7 would be used to create the information product. Please be as specific as possible.

1. Delineate the shoreline using recent imagery (aerial photography).

2. Overlay the multiple temporal datasets of shoreline. Geometric accuracy of source imagery is critical and must be normalized for tide levels.

3. Measure changes by drawing transects perpendicular to the shoreline.

Note: Must be sure to capture time of data acquisition and normalize different datasets based on tide level. The geometric accuracy of the source imagery is critical to the validity of the shoreline extraction. Shoreline changes may actually be less than the horizontal accuracy of the source data.

***Potential partnership opportunities:* Bathymetry (NOAA), Corp of Engineers for dredging data, Department of Defense for coastal military bases - high resolution aerial photos and beach nourishment activity, Port Authorities, NOAA (ocean satellite sensors), Weather & Climate (including sea level change)

6. Map Requirements (output)

Please include details like scale, extent, layers, and map unit criteria, if possible.

Map Description: Shoreline changes over time and space

Data layer Scale: 1:24,000 or better

Extent: Regional or park boundary plus a buffer area

Map Data Layers:

1) Map backdrop could be aerial photography, satellite imagery, or a current land use map data layer.
2) Park boundary
3) Vector delineation of current shoreline. If showing changes in shoreline over time, also include previous shoreline vector data layers. Areas of change can then be demarcated and colored differently for areas of accretion and erosion.

7. Tabular Data Requirements (output)

Details of any information that will be presented in the form of a report, list, or table, including headers and typical data entries.

Amount of accretion/erosion per transect measured in shift of shoreline

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Bar charts or line graph to show change over time by accretion/erosion

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

This product would likely be used on a project basis or as needed.

There are many potential users of this product, including: Superintendents, WASO, Special Interest Groups, Scientists (Regional, others), Partner Agencies, Natural Resource Managers, Law Enforcement, Lands and Planning, Interpretation, General Public, Compliance Coordinators, Network Staff, Cultural Resource Managers, and Maintenance.

Frequency of creation would depend upon the information needed from a land use / land cover change analysis. However, it is likely to be on a 5-10 year update schedule. For example, projected land use data that is available from National Land Cover Data Set is updated every 10 years. Image availability and timing of image acquisition will always be the bottleneck in this type of monitoring project.

10. Cost Estimate

Please describe the costs of producing the product with the methods described above. Please include time spent and other resources required, if known.

Cost of acquiring and processing imagery.
Manual delineation for shoreline measurement requires skilled technician.

11. What Else?

Please include any other details that would impact the creation or use of this information product.

There is the potential to partner with NOAA, FEMA and state coastal resource divisions for these products. Due to the highly dynamic nature of these systems, coastal shoreline change analyses are: critical for planning, have cultural value of information about historic changes, are relevant to disaster planning and homeland security, are critical for ecosystem integrity, and are important to commercial fishing interests.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status and trends in impervious surfaces within and near the park.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long term monitoring program.

Impervious surfaces, such as roads and man-made features, contribute to environmental impacts (e.g. air, water quality, and climate). Monitoring the status and trends of impervious surfaces will be used to create input for water and air quality models. It is also an indicator of human development.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Scale of imagery acquisition depends upon the size of the area of interest, as well as the ultimate use of the impervious surface analysis product. As always, it is important to consider the date of the image acquired for use in this project, as well as the geometric accuracy of the imagery.

4. Data/Information required to make the information product (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources as applicable.

1) Satellite imagery or aerial photography to perform impervious surface feature extraction.

2) Other helpful data layers include: land use / land cover, zoning, visitor / recreation use, structures, planimetric data, and roads coverages.

Data Sources / Partnership Opportunities: The Multi Resolution Land Characteristics Consortium National Land Cover Data, aerial photography (e.g. DOQQ from USGS), Roads data from Federal or State DOT, Government planning projects with data showing buildings, commercial data sources (e.g. GDT) for streets and encoding information, and high resolution satellite imagery (e.g. IKONOS, QuickBird).

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 7 would be used to create the information product. Please be as specific as possible.

There are many possible ways to conduct an analysis of impervious surface. Typical examples of methodology include:

1. Define the area of interest.
2. Process data based on specific question.
   Method a. Feature extraction on large area: Begin by focusing on a test area and using high resolution data create a binary map of impervious and non-

impervious surfaces. Starting with the test area, train a model (e.g. supervised or unsupervised classification) that uses LANDSAT data to predict percent impervious surface per pixel over large area.

Method b. Feature extraction on small area: Use high resolution data to create a binary map of impervious and non-impervious surfaces. For a small area, modeling techniques will not be necessary.

Method c. Manual delineation on small area: Using high resolution data manually delineate man-made features and natural impervious surfaces.

3. Validate for accuracy.

6. Map Requirements (output)

Please include details like scale, extent, layers, and map unit criteria, if possible.

Map Description: Impervious Surfaces

Scale: 1:24,000 to 1:100,000 depending on area of interest and user needs
Extent: Region, watershed, park boundary plus buffer
Layers: Backdrop of aerial photo, satellite image, or current land use
Outline or color indication of impervious surface (or percent of pixel covered by impervious surface)

7. Tabular Data Requirements (output)

Details of any information that will be presented in the form of a report, list, or table, including headers and typical data entries.

Table should include: Length / Area / Percent impervious for each time period of analysis

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Chart could be used to depict trends of impervious surface over time.

This project also has potential for development of digital interactive maps.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

This product would likely be used on a project basis or as needed.

There are many potential users of this product, including: Scientists (Regional, others), Partner Agencies, Natural Resource Managers, Lands and Planning, Interpretation, General Public, Compliance Coordinators, Network Staff, and Maintenance.

Frequency of creation would depend upon the information needed from an analysis of impervious surfaces. However, similar Georgia state-wide maps are being created on a 5

year cycle. NLCD operates on 10 year cycle. Image availability and timing of image acquisition will always be the bottleneck in this type of monitoring project.

10. Cost Estimate

Please describe the costs of producing the product with the methods described above. Please include time spent and other resources required, if known.

LANDSAT data is approx $10,000 per scene (NLCD product)
Cost can increase if focused on smaller areas.

11. What Else?

Please include any other details that would impact the creation or use of this information product.

Again, this project has the potential for interagency partnering. Impervious surface analyses are useful as a measure of land use and human impacts. This produce could be alternated with a land cover map.

Given the potential for impacts upon hydrology, impervious surface analyses can be used to make decisions regarding storm water management (runoff canals, etc).These data are also valuable input to models.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine status and trends of physiochemical variables in coastal waters.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

One of the goals of the NPS I&M program is to assess long term change in water quality in coastal waters within parks with significant natural resources. Physiochemical variables represent the core parameters recommended by NPS to provide the baseline for long-term monitoring of water quality.

By evaluating short term variability in physiochemical variables, both short term and long term changes in water quality can be assessed and modeled. The physiochemical variables include salinity concentrations, dissolved oxygen concentrations (including hypoxic and supersaturation events), pH and temperature.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Monitoring sites should be prioritized by park staff together with water quality experts. The scale of the assessment area will play a significant role in the number of sites selected.

Temporal variability can be assessed with targeted (fixed site) monitoring design.

Long term/fixed sites will provide continuous data (30 minute intervals). Siting considerations include:

- High risk sites
- Sensitive sites
- Low DO/hypoxic sites
- Potential threats
- Reference site

Spatial explicity surveys will be conducted use a representative survey monitoring design (like National Coastal Assessment – NCA). Using a rotating schedule for implementation of representative monitoring provides an assessment of individual parks and a regional assessment after completion of the cycle. The index period for sampling should be based on seasonal (typically summer) and hydrographic conditions.

Meter depth should be determined based on stratification of water column and water depth.

Deployment of meters should be standardized.

This data should be collected over long time periods for trend analysis.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

- salinity - practical salinity units (psu)
- dissolved oxygen– mg/liter (ppm) and percent saturation
- pH
- temperature – degrees C
- tidal height (depth) - meters

Standardized meter and deployment (extended deployment system would be preferable for fixed/targeted sites) should be used.

A representative survey design should include stratified random sampling (with proportional allocation based on the size of the sampling area) and adequate sampling of high priority habitats and sensitive areas. A standardized vertical profile should be used wherever possible.

FGDC compliant meta-data must be included.

Should look into real-time telimetred systems for reporting items like water temperatures to park users (e.g. fishing).

Existing Data Sources: NCA, state and municipal water quality monitoring programs, nearby NERR sites (e.g. GTM, NC NERR), COOS, STORET, UGA Marine Extension Service, academic programs, National Marine Sanctuary Program.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

For maps:
Define area of interest (boundaries) for representative monitoring.
Geolocate the sites (lat/long).

For graphs:
Define the time periods of interest.
Determine the statistical or analytical procedures for the graphs.
Develop or identify appropriate metrics for variables (e.g. % of time DO < critical value)
Plot the results.

Provide interpretation of the results based on legal requirements and established standards to include trend analysis. Determining what critical values will be used in comparisons will be essential.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Contour map of water quality variables that shows classifications of variables (for representative data).
Site location map of watershed information that shows fixed sites.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Percent of data collected for each system for each variable – represents successful completion of collection
Summaries of site characteristics (and average values for each variable) to make comparisons among parks.

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Graphs that display fixed site data:

- Temporal variation (daily, seasonal, fortnightly, in relation to storm or infrequent/unusual events) of factors
- Spatial variation across sites of factors (bar graph)
- Frequency and duration of factors
- min/max/mean/std error of variables by site over time

Graphs that display representative site data:

- Percent of the resource in a desired condition

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Temporal data should be synthesized annually.
Regional synthesis every three to five years including trends.
Telemetered data should be report real time and near real time.
GPRA goals require annual reports.

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

GPRA
Desired Future Conditions
Park's General Management Plan or Water Management Plan
Clean Water Act
Network requirements for Water Resources Division (annual)
Potential litigation

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

$7000/YSI (should have 2 YSIs per site)
$1000/year for supplies
Trained staff per site (4 days per month for collection/calibration)
Deployment costs
Transportation costs for access/retrieval
Staff time for interpretation and analysis
Dissemination costs (publication, web…)

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Should look at NERR reports for examples of info products. Standardized Graphing Reports available in CDMO.

See examples from SCECAP reports for comparing data to water quality criteria.

Periodically, data and sampling design should be reviewed and assessment for quality of data and data collection. Recommendations for modifications of data collection and reporting would be generated.

Strong recommendation from authors for 2 YSIs per site for swapping during data retrieval and calibration.

Use WCAP (Watershed Condition Assessment Program) reports to prioritize resource threats and sampling site locations.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status and trends of the quantity of freshwater entering estuarine and tidally-influenced ecosystems.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Important to measure in park systems that have significant surface flow/source because significant change can have impact on community composition. It drives all loadings, productivity and distributional patterns.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

NPS should rely on existing USGS gauging stations.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Flow:
volume
rate

Daily from gauge

Determine proportion of ungauged area and account for that.

Use the most downstream gauge.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

Nature Conservancy has a program to measure Index of Hydrologic Alteration (IHA) and it's useful to probe USGS gauge data (IHA is an analysis – not a data value).

Perform trend analysis: look for changes over time, changes in min and max. Look at historic data, too.

Compare to salinity data.

Flow data is log-normally distributed so median (not mean) is often the best indicator of central tendency of the data.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park,

watershed, or region) if known.

NA

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Change of volume and rate over time.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Baseline/initial historic analysis, then in response to community changes.

Should update analysis from existing data sources every six months.

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

NA directly to Park Service

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Analysis time

Small cost for IHA program from TNC

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Will only apply to a subset of parks where there are existing USGS gauge systems and significant sources of flow.

NPS will not create gauging stations where they don't exist now.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status and trends of human pathogens (fecal coliform and enterococci) in estuarine and tidally-influenced waters.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Important to measure to determine human use of park resources (primary contact recreation/swimming, shellfish consumption). Also provides measure of non-point source loading of human and other pathogens. Enterococcus is used as an indicator for primary contact and fecal coliform is used as an indicator for primary contact and shellfish consumption.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Survey existing data to determine where additional investigations are needed.

Design sampling and monitoring program based on water uses within each park.

Sampling frequency must conform to state criteria. Samples should be collected at low tide.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Park specific, factoring in existing uses (seasonal) and programs from other agencies.

Data: Concentrations of fecal coliform and enterococcus.

Existing data sources: county and public health organizations, EPA BEACHES (national) program for surf areas, state shellfish and water quality monitoring programs

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

Trend analysis.

Identify hot spots.

Correlate with weather events.

Report suitability of water for uses.

Seasonal announcement every two weeks: safe to swim, safe to eat.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Spatial distribution of values.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Status of suitability for use.

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Values over time.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Specific to park monitoring frequency. Updated after each data collection.

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

Many!

GPRA goals, many related to closing shell fishing

Mitigating sources of contamination

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Fund state/municipal programs to add sites to existing programs

12. What Else?

Please include any other details that would impact the creation or use of this information product.

No monitoring currently at Cumberland to determine contamination from horses. Shell fishing areas are currently closed based on assumption of contamination.

If problem is identified, seek to track source of contaminants.

Follow state standards for sampling criteria and QA.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status and trends of sediment contaminants in estuarine and tidally-influenced waters.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Provides an integrated measure of the amount of sediment contamination over the long term which contributes to evaluating ecosystem health. A spatial survey should identify if any areas within the park system are impaired. Results would be used to target areas for more intense monitoring and study, plus providing information for consideration of management actions.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Examine existing data sets from other programs (Watershed Condition Assessment) of sediment contaminants.

Initial baseline study of spatially distributed sediment contaminants, as needed. Follow standard protocols for collection ad analysis (e.g. NCA).

Focus on larger parks.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Concentration of a suite of 24 priority pollutants plus sediment grain size and TOC (total organic carbon). Suite info includes attributes for chemical name, concentration, method detection limit, QA code, units

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

Identify hot spots and areas of concern through spatial analysis.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Map sediment quality indicators at sites in each park

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

% of the park (on an aerial basis) that doesn't meet limits for each chemical

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Charts to show chemical levels in relation to limits

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Baseline creation, then decide whether to add it to long-term monitoring program based on results. Likely to be repeated every five years.

Results could spur interest from other agency's use.

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

A few states have sediment quality criteria for conformance.
Policy considerations regarding disturbance of the sediments.

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Max: $1000 per site (lab cost)

Should consider borrowing equipment for sampling and collecting

Try to partner with state agencies with collaborative costs

12. What Else?

Please include any other details that would impact the creation or use of this information product.

For contracting purposes: Must have detection limits below levels of concern (see NCA)

These measures are highly sensitive to quality issues in the collection, handling and analysis of the samples.

Be very specific in bid requests regarding quality issues.

Incidence of problem areas might trigger additional assessments for tissue contaminants. Other sources for tissue data include: Mussel Watch, states. Mussel Watch may consider adding stations.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine status and trends of physiochemical variables in rivers, streams and lakes.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

One of the goals of the NPS I&M program is to assess long term change in water quality in rivers, streams and lakes within parks with significant natural resources. Physiochemical variables represent the core parameters recommended by NPS to provide the baseline for long-term monitoring of water quality.

By evaluating short term variability in physiochemical variables, both short term and long term changes in water quality can be assessed and modeled. The physiochemical variables include conductivity, dissolved oxygen concentrations (including hypoxic and supersaturation events), pH and temperature.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Monitoring sites should be prioritized by park staff together with water quality experts. The scale of the assessment area will play a significant role in the number of sites selected.

Temporal variability can be assessed with targeted (fixed site) monitoring design.

Long term/fixed sites will provide continuous data (30 minute intervals). Siting considerations include:

- High risk sites
- Sensitive sites
- Low DO/hypoxic sites
- Potential threats
- Reference site
- Availability (frequency, location and parameters) of data from existing sources
- Personnel resources

Spatially explicit surveys will be conducted using a representative survey monitoring design (see EPA examples and NAWQA/USGS). The index period for sampling should be based on seasonal (typically summer) and hydrographic conditions.

Ecosystem boundaries should be factored into the sampling design to define major in-flows and out-flows.

Meter depth should be determined based on stratification of water column and water depth.

Deployment of meters should be standardized.

These data should be collected over long time periods for trend analysis.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

- conductivity – micro Siemens/cm
- dissolved oxygen– mg/liter (ppm) and percent saturation
- pH
- temperature – degrees C
- water depth – meters
- lat/long - UTM

Standardized meter and deployment (extended deployment system would be preferable for fixed/targeted sites) should be used.

FGDC compliant meta-data must be included.

Should look into real-time telemetered systems for reporting items like water temperatures to park users (e.g. fishing).

Existing Data Sources: state and municipal water quality monitoring programs, STORET, USGS (NWIS), academic programs, NGOs (e.g. Riverkeeper), past Park researchers, industry and utilities, Corps of Engineers, existing Park databases (CHAT).

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

For maps:
Define area of interest (boundaries) for representative monitoring.
Define HUCs (hydrologic unit codes) / watersheds.
Geolocate the sites (lat/long).

For graphs:
Define the time periods of interest.
Determine the statistical or analytical procedures for the graphs.
Develop or identify appropriate metrics for variables (e.g. % of time DO < critical value)
Plot the results.

Provide interpretation of the results based on legal requirements and established standards to include trend analysis. Determining what critical values will be used in comparisons will be essential.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Site location map of watershed information that shows fixed sites with classification of results displayed

See examples of watershed maps from USGS.

Define uniform scale for the drainage network.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Percent of data collected for each system for each variable – represents successful completion of collection
Statistical summaries of site characteristics to make comparisons among parks.

Examples: max daily average DO, minimum daily average DO, percent of time and/or samples exceeding state standards or other critical values.

Include units.

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Graphs that display fixed site data:

- Temporal variation (daily, seasonal, fortnightly, in relation to storm or infrequent/unusual events) of factors
- Spatial variation across sites of factors (bar graph)
- Frequency and duration of factors
- min/max/mean/std error of variables by site over time

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Temporal data should be synthesized annually.
Regional synthesis every three to five years including trends.
Telemetered data should report real time and near real time.
GPRA goals require quarterly reports for rivers and streams.

States are required to assess available data every two years (Clean Water Act).

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

GPRA
Desired Future Conditions
Park's General Management Plan or Water Management Plan

Clean Water Act
Network requirements for Water Resources Division (annual)
Potential litigation (e.g. Water Rights)
State rules and regs regarding analysis and water quality standards.
Wild and Scenic Rivers Act
Wilderness Designation
Dam licensing and re-licensing

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

$7000/YSI (should have 2 YSIs per site)
$1000/year for supplies
Trained staff per site – need more information on frequency of calibration required
Deployment costs
Transportation costs for access/retrieval
Staff time for interpretation and analysis
Dissemination costs (publication, park visitor information, web… USGS NBII?)

NSF's NEON program may have useful cost information.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

See examples from SCECAP reports for comparing data to water quality criteria.

Periodically, data and sampling design should be reviewed and assessment for quality of data and data collection. Recommendations for modifications of data collection and reporting would be generated.

Use WCA (Watershed Condition Assessment) reports to prioritize resource threats and sampling site locations.

Local watershed assessments may be available for consideration of sites and partnerships (e.g. The River Basin Center at UGA).

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine status and trends of nutrient concentrations in rivers, streams and lakes.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

One of the goals of the NPS I&M program is to assess long term change in water quality in rivers, streams and lakes within parks with significant natural resources.

By evaluating short term variability in nutrients, both short term and long term changes in water quality can be assessed and modeled. The primary nutrient values of interest include:

- Total Nitrogen: Total Kjeldahl Nitrogen (TKN) together with Nitrate plus Nitrite
- Ammonia
- Total Phosphorus as Phosphate

Other non-nutrient values to consider collecting simultaneously include:

- Orthophosphorus
- Total Organic Carbon
- Dissolved Organic Carbon

It is widely documented across ecoregions that increased nutrients affect ecosystem processes.

These parameters will be collected simultaneously with other data, e.g. during the biological survey.

The importance of these parameters to park managers includes:

- Total Nitrogen: Total Kjeldahl Nitrogen (TKN) together with Nitrate plus Nitrite and
- Total Phosphorus as Phosphate and
- Orthophosphorus (is the bioavailable form):
    - primary nutrients for plant growth
    - too much can give you more plant growth in streams than is desired
    - leads to eutrophication
- Ammonia
    - toxic to aquatic organisms at certain concentrations
- Total Organic Carbon and
- Dissolved Organic Carbon
    - measure of productivity
    - useful to wasteload allocation modeling

These values should be considered in a regional or watershed based context.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Priority will be given to collecting these parameters (monthly?) during visits to fixed sites. Use existing available data to determine which parks need a substantial baseline study (variability would be a significant factor). Consider strategies for an adaptive monitoring program based on baseline and monthly fixed site results. For example, on a five year rotating basis, consider adding monthly or quarterly collection for one year or consider using a representative survey throughout a park (possibly probabilistic, e.g. EMAP protocol) Use pilot projects or specific study to perform more extensive monitoring in areas with special needs and/or to interpret trends.

Monitoring sites should be prioritized by park staff together with water quality experts. The scale of the assessment area will play a significant role in the number of sites selected.

Temporal variability can be assessed with targeted (fixed site) monitoring design.

Site selection considerations include:

- High risk sites
- Sensitive sites
- Low DO/hypoxic sites
- Potential threats
- Reference site
- Availability (frequency, location and parameters) of data from existing sources
- Personnel resources

Spatially explicit surveys will be conducted using a representative survey monitoring design (see EPA examples and NAWQA/USGS). The index period for sampling should be based on hydrographic conditions (low flow).

Ecosystem boundaries should be factored into the sampling design to define major in-flows and out-flows.

Meter depth should be determined based on stratification of water column and water depth.

Deployment of meters should be standardized.

These data should be collected over long time periods for trend analysis.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

- Total Nitrogen: Total Kjeldahl Nitrogen (TKN) together with Nitrate plus Nitrite
- Ammonia
- Total Phosphorus as Phosphate

Optionally:
- Orthophosphorus
- Total Organic Carbon
- Dissolved Organic Carbon

Registration data:
- water depth – meters
- lat/long - UTM

FGDC compliant meta-data must be included.

EPA or state approved sample collection and analytical methodology should be employed.

Existing Data Sources: state and municipal water quality monitoring programs, STORET, USGS (NWIS), academic programs, NGOs (e.g. Riverkeeper), past Park researchers, industry and utilities, Corps of Engineers, existing Park databases (CHAT).

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

For maps:
Define area of interest (boundaries) for representative monitoring.
Define HUCs (hydrologic unit codes) / watersheds.
Geolocate the sites (lat/long).

For graphs:
Define the time periods of interest.
Determine the statistical or analytical procedures for the graphs.
Develop or identify appropriate metrics for variables (e.g. % of time value < critical value)
Plot the results.

Provide interpretation of the results based on legal requirements and established standards to include trend analysis. Determining what critical values will be used in comparisons will be essential.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Site location map of watershed information that shows collection sites with classification

of results displayed

See examples of watershed maps from USGS.

Define uniform scale for the drainage network.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Statistical summaries of site characteristics to make comparisons among parks.

Examples: percent of time and/or samples exceeding state standards or other critical values.

Include units.

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Graphs that display fixed site data:

- Long term or seasonal variation of factors
- Spatial variation across sites of factors (bar graph)
- min/max/mean/std error of variables by site over time

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Data should be synthesized annually.
Regional synthesis every three to five years including trends.

GPRA goals require quarterly reports for rivers and streams. Need to ascertain specific water quality goals.

States are required to assess available data every two years (Clean Water Act). Assessed on odd numbered years, reported in even number years.

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

GPRA
Desired Future Conditions
Park's General Management Plan or Water Management Plan
Clean Water Act
Network requirements for Water Resources Division (annual)
Potential litigation (e.g. Water Rights)
State rules and regs regarding analysis and water quality standards.
Wild and Scenic Rivers Act
Wilderness Designation

Dam licensing and re-licensing

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Lab costs for analysis (approx $50/sample for minimal profile)
Trained staff per site
Transportation costs for collection
Staff time for interpretation and analysis
Dissemination costs (publication, park visitor information, web… USGS NBII?)

12. What Else?

Please include any other details that would impact the creation or use of this information product.

See examples from SCECAP reports for comparing data to water quality criteria.

Periodically, data and sampling design should be reviewed and assessment for quality of data and data collection. Recommendations for modifications of data collection and reporting would be generated.

Use WCA (Watershed Condition Assessment) reports to prioritize resource threats and sampling site locations.

Local watershed assessments may be available for consideration of sites and partnerships (e.g. The River Basin Center at UGA).

State standards are being developed for Total Nitrogen and Total Phosphorus for rivers and streams now. Ammonia standards are currently in place for SC based on permit limits.

CHAT would likely have most significant variability.

Should explore data and information available from watershed associations. May be useful for dissemination, too. May be able to direct you to cooperative private property owners.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine status and trends of flow dynamics in rivers and streams.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

One of the goals of the NPS I&M program is to assess long term change in water quantity in rivers and streams within parks with significant natural resources. River flow variables represent fundamental physical data needed to manage park resources and provide a baseline for interpreting long-term ecosystem change.

Variability in flow can be tracked and compared to historical norms (even though available historic data reflects impacts of non-natural interventions (e.g. dams)).

Park managers will need this information to identify and maintain in-stream flows necessary to sustain biological communities and ecosystem integrity.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Need fixed sites (gauging sites) to acquire long-term data. Average discharge over a 24 hour period is typically used (15 or 30 minute samples based on USGS standard).

Instantaneous flows collected as part of synoptic sampling events allow interpretation of nutrient loading and biological data from individual sources and under exceptional circumstances (e.g. flood).

USGS has well-established standards for gauging flow.

* gauging is the formal hydrological term for measuring a gauge.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Flows are measured in a channel cross-section by cubic feet per second. Will need to be converted to cubic meters per second.

Instantaneous measurements should be conducted according to standard USGS protocols. States use the same.

Standardized meter and deployment (extended deployment system would be preferable for fixed/targeted sites) should be used.

FGDC compliant meta-data must be included.

Should look into real-time telemetered systems for reporting discharge. For some parks this offers an opportunity for flood hazard warning from upstream monitoring stations.

Existing Data Sources: USGS has online data for complete history of flow measurements

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

NWIS site includes location information and maps for all gages.

NPS needs to understand the contributing watershed and hydrologic connectivity. Watershed maps are available from USGS and the Natural Resource Conservation Service (free). Land use maps by watershed could be helpful here. Define HUCs (hydrologic unit codes) / watersheds.

For graphs:
Hydrograph: Plot time vs. magnitude of flow

Magnitude Frequency Curve: magnitude of the flow vs. frequency of the occurrence (e.g. magnitude of a two year flood, ten year flood, etc.)

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Map of potential flood inundation. May be a result of a flood model.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Parameters calculated from daily average stream flow data include:

- annual max (peak) flow with date – single most important hydrologic variable in many systems because it introducing functionality into the ecosystem.
- annual mean flow
- annual minimum flow with date
- range of flows (important for bio communities)
- seasonal flow information – relevant to licensing of dams
- ramping rates (rate of change of discharge) – significance is related to erosion and isolation of organisms in pools or on islands

Include units.

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

- see steps/analysis

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

USGS performs annual synthesis.

Temporal data should be synthesized annually.
Regional synthesis every three to five years including trends.
Telemetered data should report real time and near real time.
GPRA goals require quarterly reports for rivers and streams.

States are required to assess available data every two years (Clean Water Act).

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

GPRA
Desired Future Conditions
Endangered Species Act
Park's General Management Plan or Water Management Plan
Clean Water Act
Network requirements for Water Resources Division (annual)
Potential litigation
Water rights and Law of the River (dams)
State rules and regs
Wild and Scenic Rivers Act
Wilderness Designation
Dam licensing and re-licensing by FERC

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Setting up a station (TBD)
Gage maintenance (approx $6000 annually per gage)
Trained staff per site for synoptic measurements – need more information on frequency of calibration required
Synoptic measurements require special equipment (approx $2000-5000 each) – digital preferred
Transportation costs for access/retrieval – can piggyback on chemistry and nutrient sampling
Staff time for interpretation and analysis
Dissemination costs (publication, park visitor information, web…)

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Periodically, data and sampling design should be reviewed and assessment for quality of data and data collection. Recommendations for modifications of data collection and reporting would be generated.

Indicators of Hydrologic Adjustment (IHA, version 7 available now, free) is software developed by The Nature Conservancy for connecting the significance of hydrology and ecology. Likely to be significant in the future.

Use WCA (Watershed Condition Assessment) reports to prioritize resource threats and sampling site locations.

Local watershed assessments may be available for consideration of sites and partnerships (e.g. The River Basin Center at UGA, watershed associations). Volunteers!

NWIS Web is the online database for the USGS gage data. This site shows historical and real-time data. Gage locations are available there as well as current status of gages. NPS should consider supporting relevant gages that might lose current funding.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status and trends of plant community distribution and relative abundance.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

One of the goals of the NPS monitoring program is to understand the status and trends of plant community distribution and relative abundance. Data about distribution and relative abundance of plant communities allows park management to be proactive in achieving desired future conditions and move toward science-based decision making that supports a healthy ecosystem.

NPS units are a mosaic of naturally- and artificially-changing landscapes and plant communities. In order to establish scientifically-based management, it is important to understand historic, present and desired future conditions. It is desirable to acquire and provide historic data and information about status and trends in plant communities in addition to data collected as part of the NPS's ongoing vegetation mapping and monitoring program.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

First, need to agree on standard community classification for the park (presumably NVCS). If necessary, select focal communities that require change assessment.

Ten year sampling is an inventory standard but should be adjustable for monitoring local conditions. Management needs will also determine how frequently distribution and relative abundance should be assessed. Dynamics and stability (including non-natural) of an ecosystem will also influence monitoring frequency.

For field collection, would be helpful to have highly targeted project. Would need to decide if you are looking for thresholds or measuring gradients.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Vegetation maps that are being developed for NPS inventory as they become available.

Multi-spectral satellite and/or aerial imagery (e.g. TM – Thematic Mapper). NPS probably has TM data already.

Smaller habitats will need to be manually identified and mapped (e.g., with GPS).

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

The assumption here is that there is an existing baseline veg map for the park.

1) Define area of interest by determining the region of importance for each park.

2) Define time period of interest - influenced by specific monitoring objective being answered and data (aerial photo, satellite imagery, etc.) availability over time.

3) Develop/define the categories of veg cover being considered.

4) Define the scale (e.g. National Land Cover Data is 30 m pixel size). Again, this will be limited by the data availability for the time period of interest.

5) Develop/define the data summary and analysis techniques - both for assigning original veg cover classifications as well as change detection analyses.

6) Gather / collect historical and current imagery and maps to be used for classification.

7) Assign veg cover classes determined above to each data layer. This analysis will be completed for past and current time periods.

8) Quantify changes in veg cover using methods defined above.

9) Perform an accuracy assessment

***Partnership opportunities:* MRLC, Georgia GAP, SE GAP, adjacent land management agencies, NARSAL, CRSMS, NatureServe.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Relatively large scale (e.g. < 1:24,000) based on the integrity of the data

Layers: historic, current and desired future condition vegetation communities polygons (as available), administrative boundaries

Would be helpful to have maps that show places where changes in communities have occurred.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

area (# of acres/hectares) and percent by year by community

* note where parks have gained or lost acreage over time

Should also include patch size for vegetative communities as well as changes in fragmentation for each of those communities over time.

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Bar graph or pie chart of change over time

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Creation: Park-specific but not to exceed every ten years
Use: park-specific (e.g. project proposals, management plans)

Users: park management, planning staff, scientists, partner agencies, interpretation, cultural resource managers, maintenance

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

GPRA goals

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Acquisition of data based on area of interest (special project or park-wide).

Spatially and conceptually, using photo interpreted data may be more labor-intensive but offer finer scale compared to multi-spectral satellite data analysis (less expensive, coarser scale).

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Need to be certain that consistent vegetation classification standards are being used by each parks. The National Vegetation Classification Standard has been adopted by NPS. Minimum mapping units are addressed in NPS protocols.

Need to be alert to technology changes and be prepared to adopt new technologies for the best use in combination with traditional approaches.

Data quality, ground-truthing and accuracy must be addressed at each stage of monitoring.

Some results from veg cover change may be useful for national policy (e.g. loss of dune habitat).

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status and trends of plant community structure and composition.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Some communities are more stable and some are more dynamic with regard to their internal composition. By understanding trends and change in structure and composition of a plant community, a manager can track subtle and dynamic trends in a larger ecosystem context or also in microhabitats. Critical to management is the understanding of status in relation to benchmarks or the range of desired conditions for a community.

Managing for desired conditions likely implies a suite or range of conditions vs. a single point. Management's goal conditions are subject to change due to legal requirements, politics, jurisdiction, resources, etc. The monitoring strategy needs to be robust regardless of the particular goal conditions. A statistically rigorous sampling design is required to provide scientifically useful monitoring of ecosystems.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Various ecosystems (e.g., upland, maritime, riparian, prairie/grassland, and wetland forest communities) will require individual attention for sampling design.

Consider a modular approach so that sampling is consistent across similar ecosystems.

Look for opportunities to merge fire effects monitoring strategy with plant community monitoring.

Opportunistic monitoring should also capture information that programs across the Park Service need (e.g., T&E species information, fuel load data …) and a mechanism to pass that along to the appropriate parties and management for planning (e.g., ID red and yellow flags as defined by other programs).

Need quality control for error estimation based on the sampling technique.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Every variable should tie back into status and trends of long (e.g. 50 years) and short (5-15 years) term change for this community.

Overstory – species, % canopy cover
Midstory

Understory
Fuels

More on this topic in discussion notes.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Areas of change in composition and structure

Areas of native and non-native composition

Distribution of health and non-health in communities

Will be driven by the management question. Maps can be helpful for showing variability of structure or species diversity.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Rate of change

Comparison to desired future condition

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Change over time

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Would like to be able to be able to estimate changes annually.

Will be based on how frequently data can be created.

Reports should reference when data was last collected.

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

T&E and non-native species issues will affect this.

GPRA goals

Political considerations around fire and fuels

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Lots.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Be prepared to add and accommodate new properties in the monitoring design.

Potential Partners: FIA, LandFire (lead is FS)

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine status, trends and composition of bird populations.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

A wide range of bird species diversity offers a variety of recreational, educational and economic opportunities. Because birds occupy every possible habitat within the network, they have broad applicability for resource management and policy decision-making. Monitoring long-term status, trends and composition of bird populations is important because bird populations are quality indicators of environmental health variables (e.g. habitat quality, water quality, contaminants).

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Site selection criteria: acreage, uniqueness/importance of the habitat (e.g. shorebird surveys at park with beach resources, migratory songbirds at Kennesaw), seasonality, overall park conservation considerations

Basic survey technique:

- Partners in Flight (PIF) point counts for breeding daytime landbirds
- Add distance estimation for density estimation and probability, trends
- 250 meter grid
- 10 minute point count with 3/5/10 intervals
- Maximum radius: 100 meters
- In non-breeding season, supplement with area searches (usually 2 hectare, 30 minutes)
- Frequency: once a month recommended
- Owls:
  - require playbacks at night
- Other nocturnals (e.g. nightjars):
  - Road or trail transect
- Diurnal raptors:
  - Road transect, can add playbacks
- Secretive marsh birds or targeted species:
  - Call/response surveys for along transects or at points
- Colonial wading birds:
  - Colony surveys (aerial or ground)
  - Frequency - minimum twice during breeding season up to monthly during breeding season
- Shorebirds:
  - Breeding:
    - Colony surveys for colonial nesters and beach surveys for territorial nesters

Twice weekly in the breeding season
Survey of entire beach and edge of important marsh areas
Non-breeding:
High tide surveys of entire beach shoreline (walking or by bicycle), once monthly
Report colored banded birds to the Breeding Bird Laboratory
Waterfowl:
Wintering:
Survey from land (census) or aerial transects
Frequency: monthly November through March
Breeding:
Wood duck nest boxes where existing

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Location data:
Park name
Date
Observer
Qualifications/Experience of observer – coded list
Tidal stage, where applicable (low, high, mid-rising, mid-falling)
Weather: (could be done at point)
Temperature
Wind code (Beauford scale – integer)

Survey data:
Time
Lat/long
Station ID
AOU Code (4 letter code for species) – multiple per point
Count per species by time interval
Observation type - Visual or aural or both
Male/Female/unknown
Juvenile/Adult
Distance estimate
Band combinations
Nest location
# of eggs
Reproductive status/nest fate: nest, hatched, fledge, fail
Flock size
Altitude
Azimuth
Elevation/Aspect/Slope
Plant species/habitat – structure and composition at the point (dominant species by

layer)
Notes column

Good source for point count national database standard: Patuxent Wildlife Research Center (Mark Wimer)

Good source for shorebird surveys: Ted Simons at NC State

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

Check that 4 letter codes for bird species were used properly.

Strong survey system implementations use drop down menus to reduce errors.

Include multiple point locations formats (e.g. decimal degree, UTM)

If you use distance estimation, there is a program called "Distance" that analyses the data to produce densities. Available free online.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Possible layers:

survey locations (points)
vegetation data (remotely sensed or field collected)
road and trail network
land ownership
topographic map
rivers and streams
wetlands
aerial photo
nest and nest colony locations
roost sites
reproductive success
vector map of shoreline (preferably yearly)
impervious surface
buildings
soils

For landbirds, would not typically map species locations except for special cases (e.g. painted bunting)

For waterbirds, shorebirds, raptors, etc., point specific data may be more relevant.

Offer various scales, depending on situation.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Relative Abundance/Density by species (by season, by habitat, etc)

Species by lat/long

Species richness/composition by season or park or other

Frequency of occurrences by species

Observation data by species, gender, status, observer

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Bar chart comparing densities among habitat

Seasonal trends

Yearly trends

Important to consider confidence interval (degree of accuracy) around means

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Create at least yearly, maybe seasonally

Some data would be used daily, especially shorebird locations.

Analysis of things like songbirds would be annual with trends after 5 to 10 years.

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

Guardian information on T&E species – legal constraints that control how that information is released
GPRA
Endangered Species Act
Migratory Bird Treaty Act
Local park policy like tour schedules
Bald and Golden Eagle Protection Act

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

One person visiting four parks, all species, visiting year round, over two years – est.

$35K

Training for a crew (annual): $3000 one time for PowerPoint presentation (would need to be redone for southeast region)

Distance estimation training (2 day) from John Alexander (Klamath Bird Observatory): $1000/day est.

USFS offers 2 week Bird intro course - $600/attendee
USFS refresher course is free
GA DNR offers "Boot Camps" that are free

Specialized training recommended for NPS protocol

Experienced survey personnel required to identify extensive species by song and sight

Hearing tests are necessary

Seashores could use a Student Conservation Corp person ($25K/yr) for daily shorebird survey (March – July) - would need appropriate screening and training

Helicopter or airplane rental for waterbird surveys: $500/hr commercially
(GA DNR has field helicopters at $150/hr)

Access to small boat with outboard for marsh surveys

Equipment:
Range finders - $200
Spotting scopes - $1500
Binoculars - $1000
Handheld GPS - $500
Cameras – Digital SLR with image stabilizing 400mm lens: $1500 for lens, $2500 total

Internally, USFS spends $2000 to outfit a birder (vest, binoculars, etc), $100/pt – per year
Contracts have ranged from $40 to $120/point

These estimates could easily be low compared to professional contracting.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Region 8 of Forest Service uses R8Bird (12 years of data) – contact person is Margaret Griep, access database

Must screen contractors very carefully. Strong skills for identifying birds by song and call are actually extremely rare.

GA DNR and Gary/USFS can recommend contractors and volunteers that are well-qualified.

Prioritization:
- Look at federal and state bird priority lists and bird conservation plans
- Partners in Flights
- NABCI – North American Bird Conservation Initiative
  - Consortium of multiple groups (shorebird group, partners in flight...)

Be cautious when performing statistics on trends – much research available (universities, Breeding Bird Survey lab, Patuxent Wildlife Research Center)
- 1 or 2 years of data doesn't provide a trend
- Many confounding variables

Small area of some parks makes it virtually impossible to determine trends and populations on the landscape scale.

Tying NPS surveys into other bird conservation initiatives will make it much more relevant on the landscape scale.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the extent to which changes in habitat quality / availability affect birds.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Habitat is probably the major factor affecting the status of a bird species. This data would provide information for conscious decision-making and pro-active management (whether that is executing a particular action or purposely leaving something alone).

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Data collection techniques are very similar to the Status and Trends product for bird populations.

Vegetation classifications and habitat mapping will be available from the remote sensing efforts; finer scale variables on the ground might also need to be measured (e.g. snags, downed woody debris, forested wetlands, and other features below minimum mapping unit).

Historical information may be valid to current and future management: change detection analysis.

Vegetation sampling would be necessary to assess habitat.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Overstory layer:

- Forest type
- Age
- Successional class
- Height
- Canopy %
- Basal area: hardwood/conifer/hard mast
- DBH

Midstory layer:

- Deciduous
- Coniferous
- Evergreen
- Canopy %

Shrub layer;

Deciduous
Coniferous
Evergreen
Canopy %

Understory layer:
Woody
Forb/sedges
Grasses
Canopy %

Ground description

Cavities and snags:
Cavities > 12
Cavities >20
Snags>12
Snags>20
Snags >12 w/cavitites
Snags > 20 w/cavities

Water characteristics:
Depth
Fresh/brackish/salt
Flowing/standing

(These data types borrowed from USFS R8Bird.)

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

Statistical analysis to support output products.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Finer scale veg maps categorized by structure

Maps to show habitat change – based on historical information

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

% change in habitat type by year
habitat area by species richness/density/relative abundance
habitat use vs. availability

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Regression analysis
Principal components analysis
Ordination

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Based on management questions – most probably long-term based on habitat changes and habitat type.

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

Park management plan

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Same as Population products plus extra time to collect veg data and to perform veg analysis

Need training to collect veg data

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Any kind of habitat management and monitoring is going to generally be a many-year or many-decade situation.

Need to be prepared for long-term stewardship of data spanning multiple generations of staff.

For any veg analysis, many of the variables are auto-correlated. Easy to arrive at faulty conclusions without proper statistical analysis. Need experts in statistical vegetation analysis rather than a pure statistician.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the extent to which visitor use of natural areas affects bird distribution and abundance within the park.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

The fact that humans can negatively impact various aspects of bird conservation and ecology is well documented. Given the role of unmanaged recreation and other human activities on NPS lands, identifying and managing these impacts is crucial to mitigate impacts on bird species.

Given that human activities and loss of habitat is increasing in the east, the biological significance of each park is increasing.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Priority should be placed on shorebirds, grassland birds, secretive marsh birds, and colonial nesters, recognizing that there may be other priorities in the future. These birds are particularly vulnerable due to their habitat and ecology and accessibility of these areas to people.

Identify recreational pressures at each park (e.g., beach driving, horseback riding, beachcombing, fishing, dogs, boating, etc). Possibly estimate or census human use. Aerial photography can be useful, too.

Measuring human impacts must use an appropriate sampling design including spatial and temporal factors as well as patterns of human use.

Sampling design must be done in a way that promotes tie in with veg and population data.

Well established example is creel counts in fisheries management.

Survey design should be consistent among parks with similar habitats and recreational uses.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Status and trends of bird population data plus:

Biological data:

Productivity
Time budgets for specific behavior (quantifying bird behavioral responses to human activities)
Presence/absence at a finer scale temporally than the standard bird surveys

Human activity data:
Numbers
Impact of specific activities
Duration
Location
Pets
Presence/absence of active "people" management (e.g. signage, closed areas)

Estimating human disturbance vs. censusing is a sampling issue that should be considered.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Grid coverages (100m) that show human use spatially – these could be correlated with productivity maps.

Map showing human density/activity over time.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Numbers of people vs. specific locations

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Human activities vs. time (by tide, season, week, hour…)

Bird productivity and numbers vs. human density among parks

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Highly variable – daily for nest scale up to long-term (decades) changes in impacts.

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

This could lead to alterations in access patterns and park rules.

Endangered Species Act
Migratory Bird Treaty Act

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Depends on the scale.

Aerial photography costs – helicopter or fixed wing.

Can be worked into normal nesting bird beach surveys.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

May be difficult to infer specific recreational activity.

These types of surveys would be extremely valuable in educating the public.

Level of human access and the opportunities for park service staff to inform people varies across the parks.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the incidence and prevalence of diseases in amphibians.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Worldwide diseases are considered to be one of the causes of amphibian population decline and may be of concern in the southeast.

There are some southeastern species of reptiles where disease is suspected to be a cause of decline, but concern over this issue is less universal and less understood. Therefore this template focuses on amphibians.

Phase 1 would determine which diseases occur at park units. Phase 2 could determine the frequency and distribution of specific disease occurrence.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Consult with USGS wildlife health center for specific sampling design protocols.

Specimens collected during population studies and road monitoring studies could be submitted for disease analysis.

Use incidental encounters with suspected diseased individuals to identify occurrence of diseases.

Special efforts to sample recently metamorphosed individuals may be warranted.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Collection site information
Species collected
Age class
Disease incidence reports

Consult for further details on data requirements

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

Sending samples off to lab for analysis
Summarize lab results

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Map indicating where diseased animals were collected
Layer indicating visitor use areas for possible correlation with disease incidence

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Summary of lab results by species and site

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Periodic reporting or as driven prevalence and/or type of disease recorded

10. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Consult with USGS health center for costs. Costs may be covered by health center.

11. Legal / Policy issues

Take appropriate cleanup of equipment or isolation of equipment to site to minimize disease transfer.

Collection permits

12. What Else?

Please include any other details that would impact the creation or use of this information product.

This protocol does not cover malformation assessment – different preservation of specimen procedures may be necessary to assess malformation causes rather than disease.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the effects of road mortality on reptiles and amphibians.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

In some cases, road mortality can have a significant impact upon reptile and amphibian populations. Monitoring would assess the extent of this mortality to determine if mitigation measures are required, such as eco-passages.

An analysis of important reptile and amphibian habitat (amphibian breeding migration and dispersal, turtle dispersal) and proximity to roads could help guide selecting sites to conduct this monitoring. Level of traffic on routes of interest would also be a consideration.

There are T&E species where it is known that road mortality is having a significant impact on species populations. Examples include: indigo snakes at CANA, Atlantic salt marsh snake? At CAHA, red-belly turtle at CAHA, pine snake at CANA and TIMU.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Identify roads or sections of roads near significant habitat as described above. This protocol would involve road transects and driving done on a daily basis (carcasses will be scavenged or rendered unidentifiable).

Refer to the USGS Haynes Prairie eco-passage monitored before and after installation of the eco-passage (Ken Dodd). David Nelson at U. South Alabama or Matt Aresco at UFL have also worked on road mortality studies.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Species ID
Sex ID
Female with Egg
Road Segment
Date
Time
Temperature over last 24 hours
Rainfall over last 24 hours
Barometric pressure over past 24 hours
Index of Traffic Volume
Photo Documentation
GPS mortality sites

Weather data can be for park in general, unless the park is large and may be misrepresentative.

If the specimen is relatively fresh and unscathed, this could generate museum specimens.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

Calculate total number by species or species group, by segment of road and time period of interest. Calculate total number of females with eggs.

Determine the species most affected. Kimberly Andrews SREL is looking at different snake species and road mortality levels.

Correlate road mortality with traffic volume by species or species group.

Relating mortality to total population numbers is only possible where more intensive population research is ongoing (e.g. indigo snakes at CANA).

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Road network attributed with relative traffic volume
Adjacent habitat
Mortality Layer – as both point coordinates for each incident and an attribute for level of mortality along specific road segments

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Species by road segment table with number killed

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Total kill or mortality rates by season, by species, and by road segment and by weather parameters.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Annual reporting or general reporting schedule should be adequate. This would need to be done more frequently for parks where Federal or State listed species are being affected.

10. Legal / policy issues

This monitoring could feed into conservation efforts for federal and state listed species.
Collection permits for specimens
Establish / follow established wellness and safety protocols

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Low cost. Transects may be incorporated into other ongoing projects. If data indicates

that eco-passages are necessary then costs increase for installation of eco-passage.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Other visitor use interactions potentially worth monitoring, but requiring different methods from above, include:

Effects of lighting on nestling sea turtle dispersal
How visitor use may impact nest site selection for sea turtles
How visitor use may impact nest site selection for fresh water turtles on sandbars
Poaching, collecting of herps and/or malicious killing of snakes
Habitat fragmentation due to roads and hiking trails
Affects of subsidized predator populations (due to litter) on herps
Subsidized predators include: raccoons, foxes, feral cats, crows, gulls
There is the potential to combine efforts with bird and/or mammal monitoring

Indirect effects on key habitats such as high use areas near or through wetlands, trails and drainage issues.

Boating impacts – strikes on sea turtles and terrapins

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine effects of hydrology on reptiles and amphibians.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

The group couldn't come up with any significant network-wide issues related to hydrologic effects on reptiles and amphibians. Certain parks may have issues, such as HOBE and effects of dam released water – which may affect turtle nesting. It seems that this question is more relevant for special projects. Also, FOPU and the deepening of the Savannah River shipping channel will affect the surrounding marshes which would affect diamondback terrapin habitat negatively. Also, this would have uncertain affects upon sea turtles (increased shipping =?, increased strikes, expand foraging habitat).

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

10. Legal / policy issues

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine trends in populations and distributions of reptiles.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Determining trends in populations and distributions of a broad range of reptile species with emphasis on species of management concern (e.g. T&E, G1-G3, S1-S3, non-native/invasives, habitat indicators) to provide baseline monitoring (vital signs) and inform management decisions. Monitoring reptiles in the SECN is important because the southeast supports a high number of species, including many T&E species, relative to other parts of the country.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Create stable sampling locations for the establishment of long term / baseline information. You may want to establish more "ephemeral" sampling locations related to management issues or other concerns. Sample all significant habitat types using a stratified, random approach. Sampling should occur in appropriate seasons for particular species. It may be desirable to target habitat types for certain species.

Pitfall / funnel / box traps along drift fences (snakes, lizards and small turtles)
Burrow surveys (gopher tortoise and snake associates)
Coverboards (snakes, lizards)
Various aquatic turtle traps
Pedestrian / basking / observation surveys (map turtles, snakes, any)
Sea turtle nesting surveys (Sea turtles)
Seine netting (diamondback terrapin)
Spotlight Surveys (alligators)
Constrained area search (most)
Road Cruising (snakes)
Alligator nest surveys

Mark / recapture? Labor intensive, so may be limited to species of special concern.

Refer to the guidelines in development by Southeastern PARC.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Catch per unit effort
Relative abundance
Location information
Sex (for specific species or situations)
Age / size class (for specific species or situations)

State agencies monitoring sea turtles

NASA / Dynamac is monitoring indigo snakes
There may be other state agency efforts with other species.
Academic research efforts

Ask Clay for additional information on sea turtle monitoring.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

The majority of analyses would be calculating averages and mapping locations.
Statistical analysis such as proportion of area occupied, detectability.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Map presence / absence in relation to habitat types.
Map nesting locations.
Map of potential nesting habitats (turtles).
Map of potential hibernacula (snakes).

Vegetation layer
Wetlands layer

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

You could present data from 8 in tabular form as well – allowing you to indicate statistical significance as well.

Site / habitat specific (within park) species lists.

Columns: species name, site, habitat, park, relative abundance

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Graph trends and average catch per unit effort by park unit and habitat type.
Graph of age and/or size class (where appropriate) distribution

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Once a baseline has been established, analyzed on the same schedule as general reporting frequency – for some species this may be annually.

10. Legal / policy issues

Compliance with Federal Endangered Species Act and State listed species regulations including required acquisition of collecting permits

Archaeological / cultural resources permitting for digging drift fences / pitfall traps

Visual impacts to recreational settings (maintenance of viewshed)

Code of ethics (for examples see declining amphibians task force) for handling species and visiting sites

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Priority "Indicators" are really population trends and distributions of particular species of management concern. Some of these indicators can be monitored through common protocols (e.g. sea turtles). The mix of protocols necessary or desired for a given unit depends upon the mix of species of management concern. Pitfall traps may provide a broad spectrum of species data but may not get at species of management concern.

It may be useful to develop protocol templates for each technique listed under sampling design elements. For example:

Sea turtles
Terrapins
Gopher Tortoises
Species adequately sampled by pitfall / box / funnel trap / drift fence array

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine trends in populations and distributions of amphibians.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Determining trends in populations and distributions of a broad range of amphibian species with emphasis on species of management concern (e.g. state listed, G1-G3, S1-S3, non-native/invasives, habitat indicators) to provide baseline monitoring (vital signs) and inform management decisions. Monitoring amphibians in the SECN is important because the southeast supports a high number of species relative to other parts of the country and are important environmental indicators.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Create stable sampling locations for the establishment of long term / baseline information. You may want to establish more "ephemeral" sampling locations related to management issues or other concerns. Sample all significant habitat types using a stratified, random approach. Sampling should occur in appropriate seasons for particular species. It may be desirable to target habitat types for certain species.

Pitfall / funnel traps along drift fences (all)
Gopher tortoise burrow surveys (gopher frog and other associates)
Coverboards (many salamanders and some frogs)
Aquatic funnel / minnow traps (fully aquatic and larval amphibians)
Leaf litter bags (fully aquatic and larval amphibians)
Pedestrian / observation surveys (many)
Seine netting (fully aquatic and larval amphibians)
Acoustic surveys (frogs)
Constrained area / time search (most)
Egg mass counts (all native frogs and ambystomids)
Dipnetting (fully aquatic and larval amphibians)
Natural cover sampling (e.g. rocks, logs)
Road cruising (all terrestrial and semi-terrestrial species)

Mark / recapture? Labor intensive, so may be limited to species of special concern.

Refer to the guidelines in development by Southeastern PARC. NAAMP – calling survey protocols (website: www.pwrc.usgs.gov/naamp). Measuring and Monitoring Biological Diversity Standard Methods for Amphibians (book).

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Catch per unit effort
Relative abundance

Location information

Potential state agency efforts for certain species.
NAAMP (currently only active in NC and FL. Potential for other states – GA).
ARMI
USGS National Health Center in Madison, WI for disease.
Vet schools for disease (UFL)
Academic research efforts

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

The majority of analyses would be calculating averages and mapping locations.
Statistical analysis such as proportion of area occupied, detectability.

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Map presence / absence in relation to habitat types.
Map breeding pond locations and associated uplands.

Vegetation layer
Wetlands layer
Soil type layer (add to reptile template)
Water quality – Including pH, sediment load, DO, contaminants.

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

You could present data from 8 in tabular form as well – allowing you to indicate statistical significance as well.

Site / habitat specific (within park) species lists.

Columns: species name, site, habitat, park, relative abundance

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Graph trends and average catch per unit effort by park unit and habitat type.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Once a baseline has been established, analyzed on the same schedule as general reporting frequency – for some species this may be annually.

10. Legal / policy issues

Compliance with Federal Endangered Species Act and State listed species regulations including required acquisition of collecting permits

Archaeological / cultural resources permitting for digging drift fences / pitfall traps

Visual impacts to recreational settings (maintenance of viewshed)

Code of ethics (for examples see declining amphibian population task force) for handling species and visiting sites

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Priority "Indicators" are really population trends and distributions of particular species of management concern. Some of these indicators can be monitored through common protocols. The mix of protocols necessary or desired for a given unit depends upon the mix of species of management concern. Pitfall traps may provide a broad spectrum of species data but may not get at species of management concern.

It may be useful to develop protocol templates for each technique listed under sampling design elements.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status, trends and distribution of mammals of management concern.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Monitor distribution and population change over time.

Distribution: location with respect to the landscape.

Management Concern
White Tailed Deer
Medium sized carnivores (e.g., raccoons, coyotes, and red fox)
Small mammals (disease reservoirs, food web)

T&E/Sensitive
Beach Mouse
Raf. Bat
Southeastern Bat
Northern Yellow Bat
Bobcat

Invasive/Nuisance
Feral Cats
Hogs
Horses
Feral Dogs
Nutria

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Detectability and Spatial/Temporal Variation need to be considered as part of the monitoring design framework.

Use Detectability to determine Site Occupancy Estimates

Presence/Absence data

Probability based sampling

Distance Sampling – generally along roads, but should address issues of biased estimates

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Deer
- Presence
- Location
- Date/Time
- Climate

Hogs
- Harvest Data
  - Gender
  - Weight
  - Lactating
  - Group Size
  - Health
  - Location
  - Habitat Type

Medium Sized Carnivores, Bobcats
- Site Occupancy (Percent of locations sampled)
- Detectability
- If individuals can be identified, additional population parameters can be estimated

Bats
- Site Occupancy
- Detectability
- Capture Data (Weight/Sex/Reproductive Status/Age/Health)
- Opportunistic roosts data

Small Mammals
- Site Occupancy
- Detectability
- Capture Data (Weight/Sex/Reproductive Status/Age/Health)

Horses
- Count
- Sex
- Age
- Health
- Band Number
- Identifying Features

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

Deer
- Distance Sampling
    - Record numbers and distance from observer along a transect
    - Record location along transect
    - Record Date/Time
    - Record Weather (optional) – can affect visibility

- Pellet Counts
- Aerial Surveys
- Harvest Data, if available

Hogs
- Opportunistic Sampling
- Hunting and Trapping
    - Sampling Effort

Medium Sized Mammals, Bobcats, Feral Dogs/cats
- Remote Photography
- Hair Samplers
- Covered Track Plates (Cubby Boxes)
- Vocalizations
- Trapping
- Scat

Bats
- Mist Netting
- Acoustic Sampling
- Bridge/Building/Big tree Surveys

Beach Mouse
- Live Trap
- Generally Contracted

Small Mammals
- Live Trap
- Snap Traps
- Pitfalls

Horses
- Counted once per year, at the same time, tidal condition, along the same routes
- Count individuals along pre-determined routes

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Background Layers

- Streams*
- Water Bodies*
- Land Cover Classification*
- Roads
- Topography*
- Soils*
- Developed Areas
- Park Facilities
- Sampling Locations

*Contribute to habitat

Deer, Small mammals
- Abundance relative to habitat type
    - Habitat Layers
    - Density

Hogs, Horses
- Seasonal/Temporal relative to habitat
    - Habitat Layers
    - Habitat Damage Survey
    - Density

Bats
    - Habitat Layers
    - Roosting Sites
    - Foraging Habitat
    - Presence/Absence

Beach Mouse, Bobcat, Medium Sized Mammals, Feral Cats, Feral Dogs, Nutria
    - Habitat Layers
    - Occurrence Locations (Site Occupancy)

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Sampling Results (Numbers of Individuals, Capture Histories)
- Seasonal Patterns
- Tidal Patterns
- Age Classification
- Sex Classification
- Reproductive Status
- Health Criteria
    - External Parasites
    - Weight/Fat
    - Injuries

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

Graph of how populations are changing over time.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

At least semi-annual reports, ideally seasonally.

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

- There may be park policies against lethal sampling.
- Techniques that affect cultural resources.
- There may be issues related to animal rights and sampling wildlife populations.
- Human health concerns when handling animals (immunizations, etc.)
- Public and political sentiment toward charismatic species.

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status and trends of productivity/survivorship in mammals.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Productivity information is collected as part of normal mammal monitoring activities; refer to "Determine the status, trends and distribution of mammals of management concern". A number of population parameters (e.g., survival, reproduction) are best evaluated with multiple year, long term monitoring that exceeds the typical three year research/monitoring effort.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Refer to "Determine the status, trends and distribution of mammals of management concern" for design elements.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

Refer to "Determine the status, trends and distribution of mammals of management concern" for collection of productivity and survivorship data.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

Refer to "Determine the status, trends and distribution of mammals of management concern."

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Refer to "Determine the status, trends and distribution of mammals of management concern."

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Refer to "Determine the status, trends and distribution of mammals of management concern."

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Need for long term data. Commitment to institutional memory!

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Need for commitment to base funding.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the status and trends of disease in mammal populations.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Potential to impact both wildlife and human populations.

- Lyme Disease
- Hanta Virus
- West Nile Virus
- Encephalitis
- Leptospirosis
- Chronic Wasting Disease
- Rabies
- Canine Distemper
- Tularemia
- Mange

Monitored under special circumstances, but not on a regular basis.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Diseases can be monitored as part of efforts to track status and trends in mammals. Refer to "Determine the status, trends and distribution of mammals of management concern."

Behavioral observation

Opportunistic sampling

If an outbreak occurs, then a specific design can be developed to monitor that particular vector species.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

- Cause of death/behavior
- Presence/Absence of the disease organism
- Immunological Monitoring
- Human Outbreaks

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as

possible.

Collect

- Blood Samples
- Tissue Samples
- Carcass Samples
- Vector Samples
- Behavior Observations (reports of unusual behavior)

Some data can be obtained from the processes outlined in "Determine the status, trends and distribution of mammals of management concern."

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

- Geographic locations of outbreak
- Visitor Use Areas

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

- Species
- Disease
- Date/Time
- Location

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

- Outbreak Cycles

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

Annual reports
Incidence driven

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

- Public Health Advisories
- Public Sentiment
- Management Actions/Options

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Long term monitoring can be expensive. Need to have flexibility to adjust to changing conditions.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

1. Title

Short, descriptive title in the format of the long term monitoring objective.

Determine the extent to which visitor use of natural areas affects wildlife distribution and abundance within the park.

2. Narrative Summary

In a short paragraph, please describe (in layman's terms): the resource issue being addressed and its importance as part of a long-term monitoring program.

Generally applies to any areas with a wildlife presence.

If there is an impact on animals in the area, such as stress or keeping them out of the area, how to manage the visitor use to minimize these impacts.

Impacts of roads related to species movement.

Types of uses: vehicle use, off-roading,

Compare affects in areas used by visitors compared with areas not used by visitors.

3. Sampling Design Elements

Please include a discussion of the following elements: site selection criteria, sampling frequency and replication, recommended number and location of sampling sites, frequency and timing of sampling.

Select samples with respect to areas used by visitors.

Visitor Use, Development, contact stations

Focus on species with critical habitat needs.

Refer to "Determine the status, trends and distribution of mammals of management concern." for other relevant sampling design elements.

4. Data / information required (input / collection)

Please describe the parameters being measured or the data being collected. Also, please indicate partnership opportunities or external data sources, as applicable.

- Number of visitors
- Date/Time
- Visitor Activities
- Location (area of park) – GPS locations of specific activities
- Record animal behavior (e.g., number of time birds were flushed off a nest or bats flushed from a roost)
- Mortality (Road Kills)
- Distribution of affected animals
- Human/Wildlife Interactions
- Locations of Trash Cans (related to raccoon abundance)

Can be either point locations or affected areas.

5. Steps required to make the information product (process / analysis)

Please describe how the data/information from Question 4 would be used to create the information product. Please be as specific as possible.

- Direct Observation
- Trail Counters
- Traffic Counters
- Remote Photography
- Boat Counts
- Aerial Photography
- Review Incident Reports
- Road Mortality Surveys
- Visitor Use Surveys

Also refer to methods described in "Determine the status, trends and distribution of mammals of management concern."

6. Map Requirements (output)

Please include details such as map description and required data layers. Also include scale and extent (e.g. park, watershed, or region) if known.

Map of specific visitor use areas (hiking trails, campgrounds, beaches, ORV (Off Road Vehicle) Zones, etc)
Sites of human/wildlife interaction.

Add this layer to the same maps described in "Determine the status, trends and distribution of mammals of management concern."

7. Tabular data Requirements (output)

Describe any information that will be presented in the form of a list or table. Please include column headers and typical data entries.

Seasonal fluctuations in visitor use and how it corresponds to animal activities.
Activity Types (Recreation, Law Enforcement, Contractors, Researchers, Habitat Management)

8. Chart or Graphical Display of Results (output)

Please describe the non-map visual outputs for this information product. Please be as specific and creative as possible.

9. Frequency of creation and use

Please describe how often this output should be created and how often it will be used.

- Annual
- During critical wildlife periods (e.g., nesting)

10. Legal or Policy Issues

Note any legal or policy considerations that impact the creation or use of this information product.

- Visitor Privacy
- Public Health Issues
- User Groups and access

11. Cost Estimate

Please describe the costs of producing the product using the methods describe above. Please include time spent and or other resources required.

Relatively inexpensive when compared with other monitoring activities.
Need OMB approval for visitor use surveys, which increases costs and time.

12. What Else?

Please include any other details that would impact the creation or use of this information product.

Appendix 7. IPDs and Associated Data Objects

IPD ID	Title	Objects
NPS-SECN IPD-0014	Determine the status and trends of adjacent, local and regional land use and land cover	
		Archives Catalog Collector Data Analysis Image Land Classification Land Cover Land Cover/Use Other Numbers Park Protocol Regional Zoning Repositories Sample Location Sampling Event Structures
NPS-SECN IPD-0022	Determine the status, trends and distribution of marine turtle populations	
		Archives Catalog Collector Data Analysis Individual Other Numbers Park Population Protocol Repositories Reptile Sample Location Sampling Event Species
NPS-SECN IPD-0044	Determine the extent to which coastal shorelines change over space and time.	
		Archives

IPD ID	Title	Objects
NPS-SECN IPD-0044	Determine the extent to which coastal shorelines change over space and time.	
		Catalog Coastal Shoreline Coastal Zone Management Collector Image Other Numbers Park Protocol Repositories Sample Location Sampling Event
NPS-SECN IPD-0045	Determine the status and trends in impervious surfaces within and near the park.	
		Archives Catalog Collector Data Analysis Image Land Classification Land Cover/Use Other Numbers Park Repositories Sample Location Sampling Event
NPS-SECN IPD-0051	Determine status and trend of physiochemical variables in coastal waters.	
		Archives Catalog Data Analysis External Water Quality Data Hydrography Marine Other Numbers Park Protocol Regulatory or Ecological Thresholds & Standards Repositories
NPS-SECN IPD-0051	Determine status and trend of physiochemical variables in coastal waters.	
		Sample Location Sampling Event Sampling Event Weather Tides Watersheds Weather

IPD ID	Title	Objects
NPS-SECN IPD-0052	Determine the status and trends of the quantity of freshwater entering estuarine and tidally-influenced ecosystems.	
		Archives
		Catalog
		Collector
		Data Analysis
		External Water Quality Data
		Fresh Water
		Hydrography
		Marine
		Other Numbers
		Park
		Protocol
		Regulatory or Ecological Thresholds & Standards
		Repositories
		Sample Location
		Sampling Event
		Sampling Event Weather
		Stream Discharge
		Surface Water
		Tides
		Water Quality/Quantity
		Watersheds
		Weather
NPS-SECN IPD-0053	Determine the status and trends of human pathogens (fecal coliform and enterococci) in estuarine and tidally-influenced waters.	
		Archives
		Catalog
		Collector
		Data Analysis
		External Water Quality Data
		Hydrography
NPS-SECN IPD-0053	Determine the status and trends of human pathogens (fecal coliform and enterococci) in estuarine and tidally-influenced waters.	
		Marine
		Other Numbers
		Park
		Performance Goals
		Protocol
		Regulatory or Ecological Thresholds & Standards
		Repositories
		Sample Location
		Sampling Event
		Sampling Event Weather
		Tides
		Water Quality/Quantity
		Weather

IPD ID	Title	Objects
NPS-SECN IPD-0054	Determine the status and trends of sediment contaminants in estuarine and tidally-influenced waters.	
		Archives
		Catalog
		Collector
		Data Analysis
		Other Numbers
		Park
		Protocol
		Regulatory or Ecological Thresholds & Standards
		Repositories
		Sample Location
		Sampling Event
		Sampling Event Weather
		Soil/Sediment Chemistry
		Tides
		Topography
		Visitor Use Activities
NPS-SECN IPD-0061	Determine status and trends of physiochemical variables in rivers, streams and lakes.	
		Archives
		Catalog
		Collector
		Data Analysis
		External Water Quality Data
NPS-SECN IPD-0061	Determine status and trends of physiochemical variables in rivers, streams and lakes.	
		Fresh Water
		Hydrography
		Other Numbers
		Park
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Surface Water
		Water Quality/Quantity
		Watersheds

IPD ID	Title	Objects
NPS-SECN IPD-0062	Determine status and trends of nutrient concentrations in rivers, streams and lakes	
		Archives
		Catalog
		Collector
		Data Analysis
		Fresh Water
		Other Numbers
		Park
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Surface Water
		Water Quality/Quantity
		Watersheds
NPS-SECN IPD-0063	Determine status and trends of flow dynamics in rivers and streams.	
		Archives
		Catalog
		Collector
		Data Analysis
		Fresh Water
		Other Numbers
		Park
		Protocol
		Repositories
		Sample Location
NPS-SECN IPD-0063	Determine status and trends of flow dynamics in rivers and streams.	
		Sampling Event
		Stream Cross Section
		Stream Discharge
		Stream Reach
		Surface Water
		Water Quality/Quantity
NPS-SECN IPD-0071	Determine the status and trends of plant community distribution and relative abundance.	
		Archives
		Catalog
		Collector
		Image
		Land Classification
		Land Cover/Use
		Other Numbers
		Park
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Vegetation Map

IPD ID	Title	Objects
NPS-SECN IPD-0072	Determine the status and trends of plant community structure and composition.	
		Archives
		Catalog
		Community
		Data Analysis
		Desired Future Condition
		Fuel Models
		Individual
		ITIS
		Other Numbers
		Park
		Photo Documentation
		Plant
		Plant Community
		Plant Population
		Protocol
		Repositories
NPS-SECN IPD-0072	Determine the status and trends of plant community structure and composition.	
		Sample Location
		Sampling Event
		Species
NPS-SECN IPD-0080	Determine status, trends and composition of bird populations.	
		Archives
		Bird
		Catalog
		Collector
		Data Analysis
		Individual
		ITIS
		Other Numbers
		Park
		Population
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Species

IPD ID	Title	Objects
NPS-SECN IPD-0081	Determine the extent to which changes in habitat quality/availability affect birds.	
		Archives Bird Catalog Collector Data Analysis Individual ITIS Land Classification Land Cover/Use Other Numbers Park Population Protocol Repositories Sample Location Sampling Event Species
NPS-SECN IPD-0082	Determine the extent to which visitor use of natural areas affects bird distribution and abundance within the park.	
		Archives Bird Catalog Census Collector Data Analysis Designated Use Area Individual ITIS Land Classification Land Cover/Use Other Numbers Park Park Visitor Use & Statistics Population Protocol Repositories Sample Location Sampling Event Species Visitor Use Activities

IPD ID	Title	Objects
NPS-SECN IPD-0083	Determine the incidence and prevalence of diseases in amphibians.	
		Amphibian
		Archives
		Catalog
		Collector
		Data Analysis
		Disease
		Disease/Pest Metadata
		Geology
		Health/Condition
		Individual
		ITIS
		Other Numbers
		Park
		Population
		Protocol
NPS-SECN IPD-0083	Determine the incidence and prevalence of diseases in amphibians.	
		Repositories
		Sample Location
		Sampling Event
		Species
		Specimen
		Tissue Sample
		Weather
NPS-SECN IPD-0084	Determine the effects of road mortality on reptiles and amphibians.	
		Amphibian
		Archives
		Catalog
		Collector
		Data Analysis
		Geology
		Individual
		ITIS
		Other Numbers
		Park
		Park Visitor Use & Statistics
		Population
		Protocol
		Repositories
		Reptile
		Road Mortality
		Roads
		Sample Location
		Sampling Event
		Species
		Specimen
		Visitor Use Activities
		Weather

IPD ID	Title	Objects
NPS-SECN IPD-0085	Determine effects of hydrology on reptiles and amphibians.	
		Amphibian
		Archives
		Catalog
		Collector
		Data Analysis
		Fresh Water
NPS-SECN IPD-0085	Determine effects of hydrology on reptiles and amphibians.	
		Geology
		ITIS
		Other Numbers
		Park
		Protocol
		Repositories
		Reptile
		Species
		Specimen
		Surface Water
		Water Quality/Quantity
		Weather
NPS-SECN IPD-0086	Determine trends in populations and distributions of reptiles.	
		Archives
		Catalog
		Collector
		Data Analysis
		Geology
		Individual
		ITIS
		Land Classification
		Land Cover/Use
		Other Numbers
		Population
		Reptile
		Species
		Specimen
NPS-SECN IPD-0087	Determine trends in populations and distributions of amphibians.	
		Amphibian
		Archives
		Catalog
		Collector
		Data Analysis
		Geology
		Individual
		ITIS
		Other Numbers
		Park

IPD ID	Title	Objects
NPS-SECN IPD-0087	Determine trends in populations and distributions of amphibians.	
		Population
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Species
		Specimen
		Water Quality/Quantity
		Weather
NPS-SECN IPD-0088	Determine the status, trends and distribution of mammals of management concern.	
		Archives
		Catalog
		Collector
		Data Analysis
		Individual
		ITIS
		Land Classification
		Land Cover/Use
		Mammal
		Other Numbers
		Park
		Population
		Repositories
		Sample Location
		Sampling Event
		Species
NPS-SECN IPD-0090	Determine the status and trends of disease in mammal populations	
		Archives
		Catalog
		Collector
		Data Analysis
		Disease
		Disease/Pest Metadata
		Health/Condition
		Individual
		Mammal
		Other Numbers
NPS-SECN IPD-0090	Determine the status and trends of disease in mammal populations	
		Park
		Population
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Species

IPD ID	Title	Objects
NPS-SECN IPD-0091	Determine the extent to which visitor use of natural areas affects wildlife distribution and abundance within the park.	
		Amphibian
		Archives
		Bird
		Catalog
		Collector
		Data Analysis
		Designated Use Area
		Individual
		Land Classification
		Land Cover/Use
		Mammal
		Other Numbers
		Park
		Park Visitor Use & Statistics
		Population
		Protocol
		Repositories
		Reptile
		Species
		Visitor Use Activities
NPS-SECN IPD-0101	Determine the status and trends in groundwater quality and quantity	
		Archives
		Catalog
		Collector
		Data Analysis
		External Water Quality Data
		Fresh Water
		Groundwater
		Other Numbers
NPS-SECN IPD-0101	Determine the status and trends in groundwater quality and quantity	
		Park
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Water Quality/Quantity
NPS-SECN IPD-0102	Determine the status and trends in air quality	
		Air Quality
		Air Quality Analysis
		Archives
		Catalog
		Collector
		Other Numbers
		Park
		Repositories
		Sample Location
		Sampling Event

IPD ID	Title	Objects
NPS-SECN IPD-0103	Determine the status and trends in soil chemistry	
		Archives
		Catalog
		Collector
		Data Analysis
		Other Numbers
		Park
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Soil/Sediment Chemistry
		Soils Inventory
NPS-SECN IPD-0104	Determine the status and trends in subsidence	
		Archives
		Biology
		Catalog
		Collector
		Data Analysis
		DEM
		Other Numbers
NPS-SECN IPD-0104	Determine the status and trends in subsidence	
		Park
		Photo Documentation
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Seismic Activity
		Soils Inventory
		Specimen
NPS-SECN IPD-0105	Determine the trends in natural disturbance regimes	
		Archives
		Catalog
		Collector
		Data Analysis
		Disturbance
		Fire History
		Insect Outbreaks
		Other Numbers
		Park
		Photo Documentation
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Wildfire

IPD ID	Title	Objects
NPS-SECN IPD-0106	Determine the status and trends in wildlife communities	
		Archives
		Catalog
		Collector
		Community
		Data Analysis
		Geology
		Other Numbers
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Specimen
NPS-SECN IPD-0106	Determine the status and trends in wildlife communities	
		Wildlife Community
NPS-SECN IPD-0107	Determine the status and trends in fish communities	
		Archives
		Catalog
		Collector
		Community
		Data Analysis
		Disease/Pest Metadata
		Fish Community
		Fish Specimen
		Health/Condition
		Individual
		Other Numbers
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Tissue Sample
NPS-SECN IPD-0108	Determine the status and trends in commercial fisheries take	
		Archives
		Catalog
		Collector
		Commercial Fisheries Take
		Data Analysis
		Other Numbers
		Park
		Repositories
		Sample Location
		Sampling Event

IPD ID	Title	Objects
NPS-SECN IPD-0109	Determine the status and trends in aquatic invertebrate communities	
		Archives
		Catalog
		Collector
		Community
		Data Analysis
		Invertebrate Community
		Other Numbers
		Park
NPS-SECN IPD-0109	Determine the status and trends in aquatic invertebrate communities	
		Protocol
		Repositories
		Sample Location
		Sampling Event
NPS-SECN IPD-0110	Determine the status and trends of stream habitats	
		Archives
		Catalog
		Collector
		Data Analysis
		Other Numbers
		Park
		Protocol
		Repositories
		Sample Location
		Sampling Event
		Stream Cross Section
		Stream Discharge
		Stream Habitat
		Stream Reach
NPS-SECN IPD-0111	Determine the spatial and temporal extent of management activities	
		Archives
		Catalog
		Collector
		Management Activities
		Other Numbers
		Park
		Repositories
		Sample Location
		Sampling Event

Appendix 8. Properties Associated with Each Object

Object	Properties
Air Quality Analysis	
	Metals Exceeding Thresholds
	Nitrogen and other Nutrients Exceeding Thresholds
	Ozone Exceeding Thresholds
	Park
	Particulates Exceeding Thresholds
	Regulatory Thresholds & Standards
	Visibility
	Wet & Dry Deposition Exceeding Thresholds
Amphibian	
	Morph Stage

Object	Properties
Archives	
	Additional Accession Numbers
	Alternate Name
	Arrangement
	Artist/Maker
	Catalog Level
	Collection Title
	Dates
	Field Site Number
	Finding Aids
	History
	Index Terms
	Key Descriptor
	Language
	Local Collection Number
	Maintenance Cycle
	Manufacture Date
	Material
	Measurements
	Object
	Organization
	Other
	Place of Manufacture
	Place of Origin
	Provenance
	Reference Terms
	Related Collections
	Site Name
	State Site Number
	Use Date
	Within Site Provenience

Object	Properties
Biology	
	DEM
	Depth
	Field Site Number
	Habitat
	Habitat/Community
	Individual
	Period/Substrate
	Related Collections
	Soils Inventory
	Species
	Type Specimen
Bird	
	Band
	Plumage

Object	Properties
Catalog	
	Accession Number
	Catalog Date
	Catalog Folder
	Catalog Number
	Cataloger
	Changed By
	Changed By Date
	Classification Line 1 (Catalog Type)
	Component Part
	Condition
	Condition Description
	Controlled Property
	Description
	Eminent Figure
	Eminent Organization
	Identified By
	Identified Date
	Item Count
	Location
	Logger Date
	Logger ID
	Maintenance Cycle
	Object Status
	Other Numbers
	Quantity
	Status Date
	Storage Unit
Coastal Shoreline	
	Image
	Tides
Collector	
	Contact Information
	Name
	Qualifications
	Volunteer Status
Community	
	Community Type
	Number of Species
	Species Present Y/N
	Total Count Per Species

Object	Properties
Data Analysis	
	Comparison to DFCs
	Comparison to Regulatory or Ecological Thresholds and Standards
	Comparison to Regulatory Performance Goals
	Model Validation
	Spatial Extent
	Temporal Extent
Desired Future Condition	
	Areas
	Processes
Disease	
	Pathogen
Disturbance	
	Area Affected
	Category (Human/Natural)
	Date
	Planned (Y/N)
	Type of Disturbance
Disturbed Area	
	Area Affected
	Category (Human/Natural)
	Date
	Planned (Y/N)
	Type of Disturbance
Fish Community	
	Beginning Time
	Comments
	Ending Time
	Method Code
	Model
	Number of Seine Hauls
	Output Voltage
	Reach Length
	Seconds

Object	Properties
Fish Specimen	
	Abundance
	DELT Anomalies
	ID Field or Lab?
	Species
	Standard Length
	Total Length
	Voucher (Y/N)
	Weight
Fresh Water	
	Conductivity
Geology	
	Age
	Common Name
	Dimensions/Weights
	Filing Group
	Major Group
	Material Type
	Vertical Datum
Groundwater	
	Water Depth
	Yield
Health/Condition	
	Cause of Death
	Disease Presence/Absence
	Injury
	Parasites
	Tissue Sample
	Weight
Image	
	Horizontal Accuracy
	Image Date/Time
	Image Source
	Image Type (Aerial Photo, Satellite, etc.)
	Scale (Pixel Size)

Object	Properties
Individual	
	Age/Age Class
	Behavior
	Detection Method
	Gender
	Health/Condition
	Photo Documentation
	Reproductive Status
	Species
	Weight/Size
Insect Outbreaks	
	Species
Invertebrate Community	
	Bottle Sequence
	Elutriation Method
	Equal Sampling Effort Procedure
	Mesh Size
	Number of Discrete Collections
	Sample Component
	Sample-Splitting Method
	Split Ratio
	Total Area of Sample
Land Cover	
	Classification System
	Classification Type
Land Cover/Use	
	Image
	Impervious Surface
	Land Classification
	Land Use
	Ownership (Park Land vs. Adjacent Land)
	Time Frame (Historic, Current, Future)
Mammal	
	Pelage
Marine	
	Salinity
	Tidal Height (Depth)
Other Numbers	
	Description
	Number
	Source

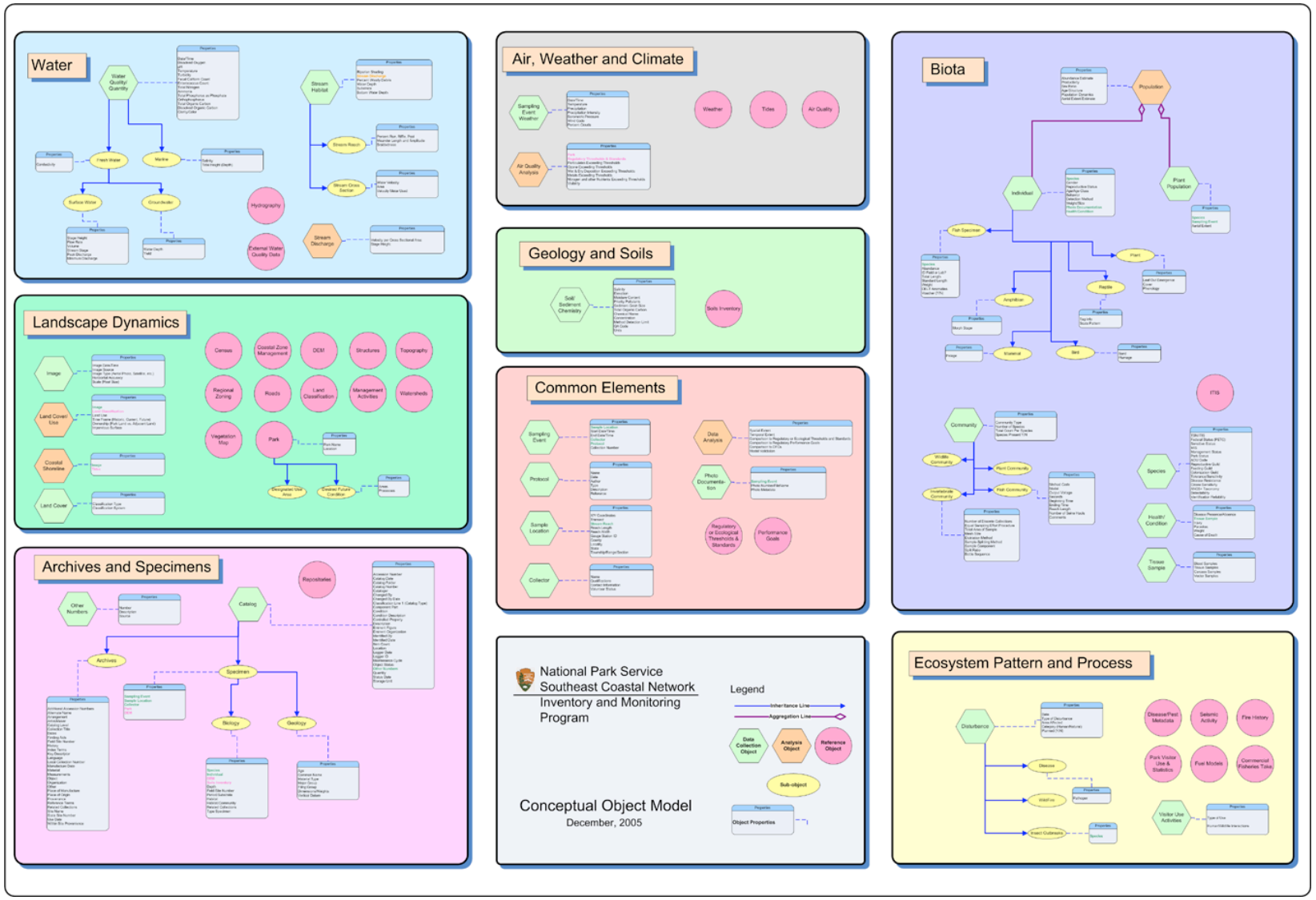
Object	Properties
Park	
	Location
	Park Name
Photo Documentation	
	Photo Metadata
	Photo Number/FileName
	Sampling Event
Plant	
	Cover
	Leaf Out Emergence
	Phenology
Plant Population	
	Aerial Extent
	Sampling Event
	Species
Population	
	Abundance Estimate
	Aerial Extent Estimate
	Age Structure
	Population Dynamics
	Productivity
	Sex Ratio
Protocol	
	Author
	Date
	Description
	Name
	Reference
	Type
Reptile	
	Scute Pattern
	Tag Info

Object	Properties
Sample Location	
	County
	Gauge Station ID
	Locality
	Reach Length
	Reach Width
	State
	Stream Reach
	Township/Range/Section
	Transect
	X/Y Coordinates
Sampling Event	
	Collection Number
	Collector
	End Date/Time
	Protocol
	Sample Location
	Start Date/Time
Sampling Event Weather	
	Barometric Pressure
	Date/Time
	Percent Clouds
	Precipitation
	Precipitation Intensity
	Temperature
	Wind Code
Soil/Sediment Chemistry	
	Chemical Name
	Concentration
	Elevation
	Method Detection Limit
	Moisture Content
	Priority Pollutants
	QA Code
	Salinity
	Sediment Grain Size
	Total Organic Carbon
	Units

Object	Properties
Species	
	ANCS+ Taxonomy
	AOU Code
	Colonization Guild
	Detectability
	Disease Resistance
	Federal Status (PETC)
	Feeding Guild
	Identification Reliability
	Management Status
	MIS
	Ozone Sensitivity
	Park Status
	Reproductive Guild
	Sensitive Status
	Tolerance/Sensitivity
	TSN/ITIS
Specimen	
	Collector
	DEM
	Park
	Sample Location
	Sampling Event
Stream Cross Section	
	Area
	Velocity Meter Used
	Water Velocity
Stream Discharge	
	Stage Height
	Velocity per Cross Sectional Area
Stream Habitat	
	Bottom Water Depth
	Percent Woody Debris
	Riparian Shading
	Stream Discharge
	Substrate
	Water Depth
Stream Reach	
	Braidedness
	Meander Length and Amplitude
	Percent Run, Riffle, Pool

Object	Properties
Stream/Lake Water Quality	
	Ammonia
	Conductivity
	Dissolved Organic Carbon
	Orthophosphorus
	Total Nitrogen
	Total Organic Carbon
	Total Phosphorus as Phosphate
	Water Depth
Surface Water	
	Flow Rate
	Minimum Discharge
	Peak Discharge
	Stage Height
	Stream Stage
	Volume
Tissue Sample	
	Blood Samples
	Carcass Samples
	Tissue Samples
	Vector Samples
Visitor Use Activities	
	Human/Wildlife Interactions
	Type of Use
Water Quality/Quantity	
	Ammonia
	Clarity/Color
	Date/Time
	Dissolved Organic Carbon
	Dissolved Oxygen
	Enterococcus Count
	Fecal Coliform Count
	Orthophosphorus
	pH
	Temperature
	Total Nitrogen
	Total Organic Carbon
	Total Phosphorus as Phosphate
	Turbidity

Appendix 9. Object Model Diagram



A full-scale version of this view of the model is available on the project web site (see Appendix 2).